The FOUNDRY

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Plant Makes Heavy Machine Tools

Melting and Crane Equipment Has Been Installed Sufficient To Handle Single Castings Up to 50 Tons and a Daily Normal Output of 100 Tons of Castings—Modern Comfort Features All Included

WITH ample space inside and out, substantial construction, adequate lighting, heating and ventilating features, with a melting capacity of 100 tons a day and crane equipment to handle it easily, the new foundry of the Toledo Machine & Tool Co., Toledo, O., furnishes an interesting example of the modern foundry for the production of machine tools and parts weighing from a few ounces to 50 tons. The company has operated an extensive machine shop for many years, but until recently has depended upon outside sources for its castings. The new foundry is the first unit of a large new plant designed to increase manufacturing facilities to a considerable extent. It is built on part of a tract of 98 acres acquired by the company on the outskirts of the city and on the opposite side of the same street from the present plant. An area comprising 25 acres has been fenced and graded to a certain extent preparatory to the erection of a completely self-contained manufacturing plant, comprising among other features and in addition to the foundry already erected, a 4-story machine shop 1250 feet long by 200 feet wide.

The property adjoins the New York Central railroad and a private track extends from the plant to Air Line Junction, affording exceptionally favorable shipping facilities both on incoming and outgoing freight. Standard gage tracks have either been laid or projected between all the units of the plant to meet all transportation requirements. A standard gage track extending into the cleaning room of the foundry provides a ready means for

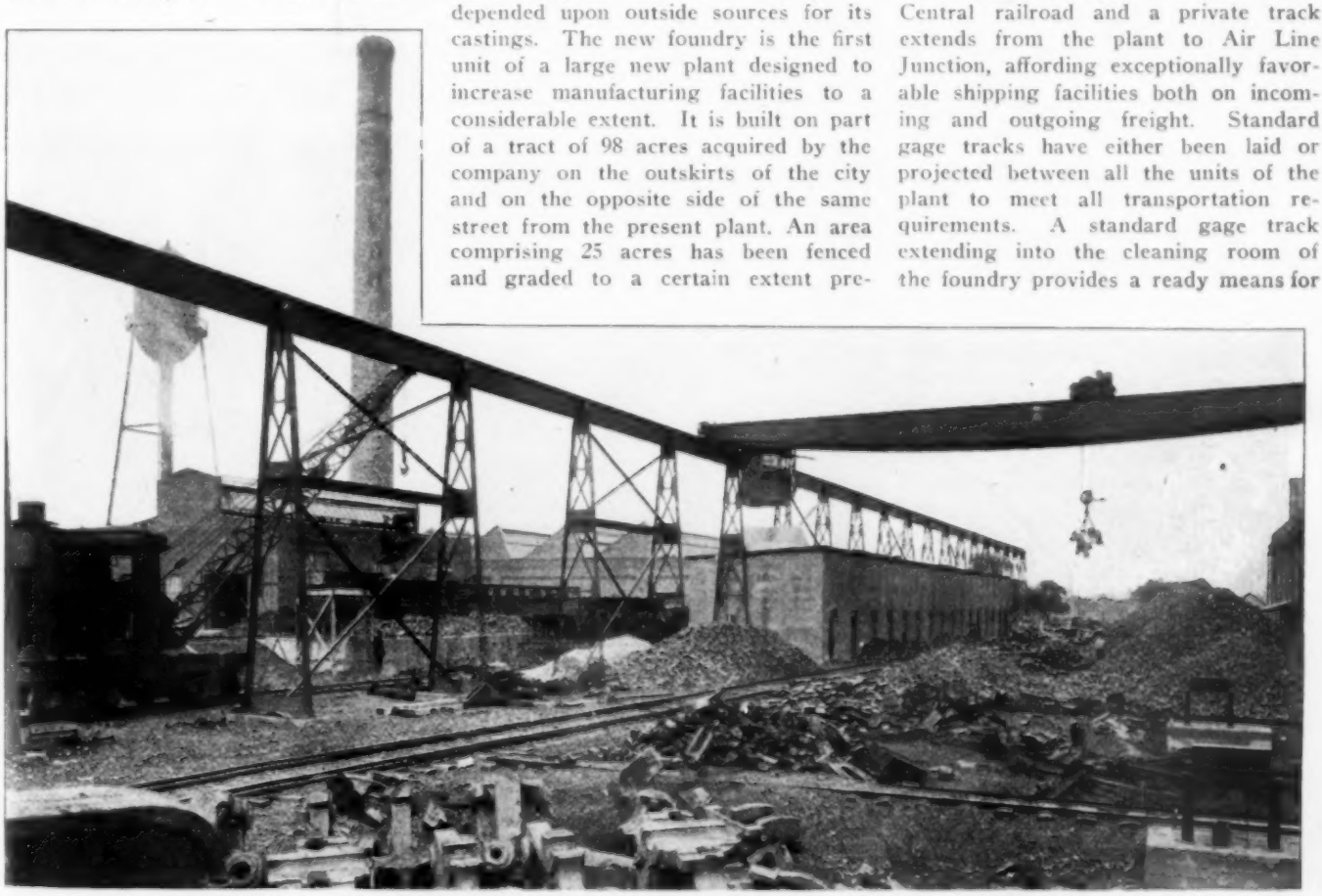


FIG. 1—A 10-TON CRANE WITH A 90-FOOT SPAN OPERATING ON A RUNWAY 450 FEET LONG IS SUPPLEMENTED BY A 10-TON LOCOMOTIVE CRANE IN HANDLING MATERIAL IN THE STOCK YARD

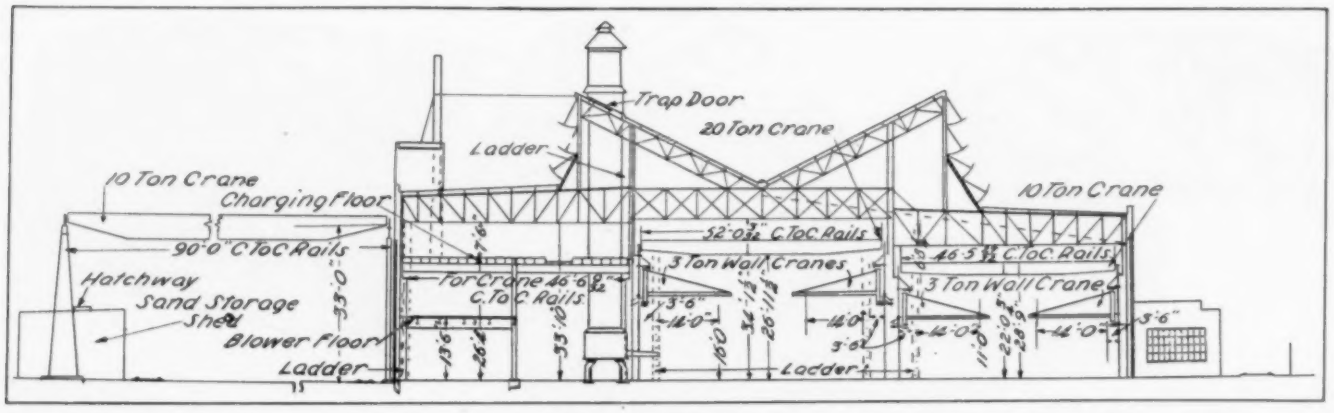


FIG. 2—CROSS SECTION OF FOUNDRY BUILDING AT ONE OF THE CUPOLAS SHOWING STRUCTURAL DETAILS

loading the castings directly on flat cars and shipping them to the present machine shop. Later the track will be diverted to deliver the castings to the new machine shop.

The foundry does not present any radical departure from the design of many shops engaged in the production of a miscellaneous line of castings, but the company has endeavored to provide a plant as nearly perfect as possible and in accordance with information gained by inspection of many of the most representative foundries throughout the country.

The foundry building of heavy steel construction, made necessary by the character of the work and the many cranes required at present is 180 x 378 feet. It is divided by two rows of 36-inch steel columns spaced on 25-foot centers into three 60-foot bays. Eventually it is proposed to extend the building 250 feet resulting in a foundry 628 feet long. The building practically is fireproof, since with the exception of the foundry office adjoining one side, no inflammable material has been employed in its construction. The roof, of the Pond truss type, is covered with concrete slabs on those portions which are not made up of heavy wire glass. The peak of the roof is 62 feet and the roof trusses 34 feet above the floor line. The window sections, set in factory glass in steel sash occupy practically all the wall space at the sides and ends of the building. Each section measures 16½ x 28 feet and extends from a few feet above the floor to the roof line of the building.

Following the natural division afforded by the two lines of columns, the classes of work handled have been segregated and assigned to the different sections. Taking them in turn the north bay, shown in Fig. 4, is devoted to light floor and machine molding. It is provided with two 10-ton cranes made by the Pawling & Harnischfeger Co., Milwaukee, traveling on a high track, and two 3-ton jib cranes made by the same company and traveling on a lower track. The large castings are made in the center bay both in green and dry sand molds. A considerable amount of this work is made in the floor, either green or skin dried, but the greater part is made in iron flasks and dried in the ovens. Iron flasks are

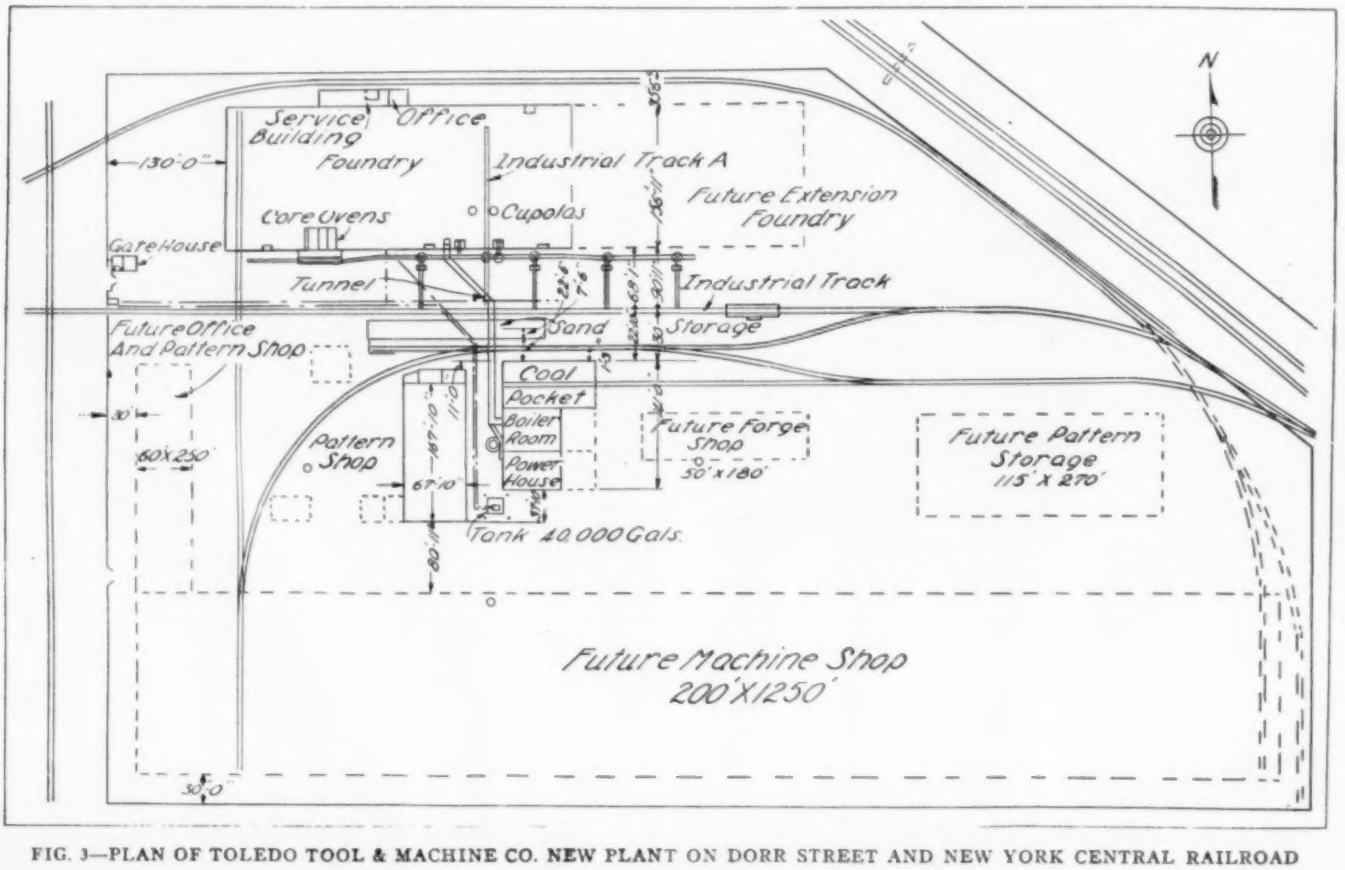


FIG. 3—PLAN OF TOLEDO TOOL & MACHINE CO. NEW PLANT ON DORR STREET AND NEW YORK CENTRAL RAILROAD

used exclusively in this section, and in a great many instances iron patterns have replaced those made of wood. Distortion of castings due to weak wooden patterns or flasks and which often is responsible for the rejection of castings in the machine shop on account of interfering with the machining allowance, is prevented by making the molds from stiff iron patterns in rigid iron flasks.

Overhead and Wall Cranes

The center bay is served by two Pawling & Harnischfeger cranes, one of 30 tons and the other of 20 tons capacity. In addition to these cranes, which span the bay from side to side at a height of 27 feet above the floor, two 3-ton wall cranes made by the same company operate the full length of the building one at each side on a track 17 feet above the floor. The light lower cranes are employed for handling cores, flasks, patterns, etc., and relieve the heavy upper cranes from a great deal of this light routine lifting. The wall cranes have a span of 25 feet, but are more flexible and convenient than the ordinary jib crane inasmuch as their range extends up and down the full length of the bay on each side.

The south bay is subdivided into a number of units including a space at one end devoted to coremaking, and served by a 3-ton Toledo crane hand controlled from the floor. The small cores are dried in a number of drawer type core ovens and the larger cores are dried on one of the three coke fired ovens, each 10 feet wide and 24 feet deep. The ovens are equipped with double tracks and cars and in addition to the cores also are employed to dry some of the dry sand molds. The larger molds are dried in a large coke fired oven, 24 x 30 feet, and 18 feet high. The tracks from the ovens extend into the main bay under the crane runways.

FIG. 5—A NARROW GAGE TRACK LAID ON THE FLOOR BETWEEN THE TWO CUPOLAS AND EXTENDING INTO THE YARD THROUGH A DOORWAY ON EITHER SIDE OF THE BUILDING IS USED FOR CONVEYING IRON TO THE NORTH BAY—IT ALSO IS USED FOR TAKING FLASKS AND OTHER SUPPLIES AND MATERIALS INTO AND OUT OF THE FOUNDRY

FIG. 4—LOADS UP TO 10 TONS CAN BE HANDLED IN THE NORTH BAY WHICH IS EQUIPPED WITH TWO 10-TON BRIDGE CRANES AND TWO 3-TON WALL CRANES

The core and facing sand are mixed in a grinding pan made by the National Engineering Co., Chicago. The sand is conveyed by a grab bucket suspended from the yard crane. It is taken from the sand storage and dumped through a chute in the wall onto the floor in the vicinity of the mixing machinery.

The two cupolas with their spouts projecting into the main bay are located in the south bay at a point that will bring them near the center of the building when the projected extension has been added to one end. The larger with a 104-inch shell lined down to 84 inches and the smaller with a 72-inch shell lined to 54 inches were supplied by the Whiting Corp., Harvey, Ill. Individual Sturtevant blowers furnish the required blast for each cupola. The larger is driven by a 100-horsepower Westinghouse motor and the other by a 60 horsepower Western Electric motor.

Elevators Handle Charge

The charging platform is 27 feet above the floor and is served by two 6000-pound elevators. A narrow gage track running parallel to the wall of the building on the outside and provided with turn tables opposite each of the elevator shafts serves to convey the material from the stock pile. Short branches extend from the main track at right angles and penetrate the piles of material in the stock yard and at no time have the men loading the charging buggies occasion to carry the material any appreciable distance. Track scales are provided at four points on the main line and furnish a ready means of checking up on the amount of pig iron or scrap in each car before it reaches the elevator shaft.

The sills of the charging doors in the cupolas are set flush with the floor and facilitate the work of charging whether it is done by hand as in the case of the smaller cupola or by a pneumatic tipping device in the case of

FIG. 6—THE PULLEYS AND LOWER BELTS ON ALL THE POWER DRIVEN MACHINES IN THE PATTERN SHOP ARE BOXED IN TO PREVENT ACCIDENTS

the larger. The 84-inch cupola is provided with two charging doors one opposite the other and longitudinally in relation to their position on the platform. The car containing the necessary amount of iron is pushed onto a movable platform in front of the charging door. A hooked clamp is thrown up to engage the axle on the truck and then the back end of the platform is elevated, a movement which forces the contents of the charging pan to flow out through the lower and open end into the cupola. It is claimed that by charging the material alternately from one side to the other that it is distributed fairly level and uniform.

Charging Platform

The charging platform, 60 x 70 feet, is large enough to accommodate the material required for a day's heat. It is provided with a number of sections of narrow gage track set closely together and by means of a transfer car operating on a track in front of the cupolas and at right angles to the short tracks, the cars can be switched easily from one point to another on the floor. By having all the material on the charging floor before charging actually begins, it is possible in case of untoward circumstances to vary or change the sequence in which the component parts of the charge are placed in the cupola.

The stock yard lies under a crane runway 90 feet wide by 450 feet long. It is served by a 10-ton crane equipped either with magnet or grab bucket for loading or unloading sand, iron or coke. A 10-ton crane made by the Brown Hoisting Machinery Co., Cleveland, also is employed for various duties in and around the stock yard including shunting cars, removal of ashes, etc. The sand storage building, 200 feet long, 25 feet wide and 18 feet high, is located at the opposite side of the stock yard from the foundry building and extends partly inside and partly outside the outer row of columns supporting the crane runway. The cars of sand spotted on the outside of the building are unloaded by a grab bucket suspended from the boom of the locomotive crane. The sand is dropped through hatchways in the roof. When the sand is required in the foundry it can be lifted by a grab bucket attached to the electric traveling crane or loaded into trucks operating on the narrow gage track leading directly into the main foundry.

The pattern shop of brick and steel construction, 69 x 168 feet, is a single-story building provided with a saw-tooth roof and a wood block floor laid on a 6-inch concrete foundation. The general layout of power tools and benches is based on the anticipated employment of 50 patternmakers. The window arrangement in walls and roof provides an even distribution of direct light on the floor and benches. A monorail suspended from the beams directly above the main gangway furnishes a ready and convenient method for conveying lumber and heavy patterns into and out of the pattern shop.

Generate Own Current

Electric current for the cranes, elevators, lighting, etc., is generated in a power house located a short distance back of the sand storage, where a 300-kilowatt direct-current generator is driven by a 400-horsepower engine. Compressed air is supplied by an Ingersoll-Rand compound steam 2-stage compressor with 9 x 14-inch steam and 10 x 14-inch air high pressure; and 14 x 16-inch steam and 14 x 18-inch air low pressure cylinders. A deep well pump raises water to a 40,000-gallon water tower the bottom of which is 98 feet above the ground and which furnishes the necessary pressure for all purposes all over the plant.

The power house occupies one end of a concrete lined excavation. The engine, generator, compressor and pump are set up on the ground level floor, but the boilers are erected on the floor of the excavation. The remainder of

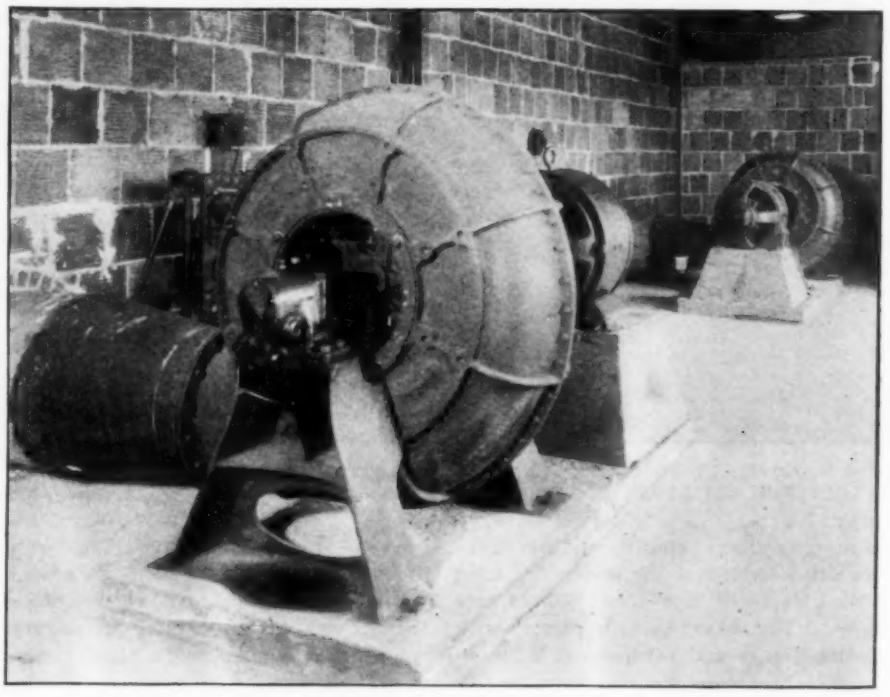


FIG. 7—THE BLOWERS AND MOTORS ARE LOCATED IN A BRIGHT, CLEAN ROOM SEPARATED FROM THE REMAINDER OF THE FOUNDRY BY A DUST PROOF TILE WALL

the excavation is used as a coal bin and has a capacity of 35 carloads. The loaded cars are shunted one at a time onto a track which spans the bin and when the hopper door on the bottom is released the coal falls into the bin by gravity.

The electric wiring, air, water and steam heating lines are taken to the foundry through a concrete lined tunnel 6 feet by 5 feet wide which connects the power house with the foundry. Waste steam from the power house is employed for heating the foundry. It is distributed through coils on the side walls and also through radiators attached longitudinally to the two rows of columns below the lower crane runway.

Drinking water fountains are attached to every second column and five small brick toilet stations, each 6 x 9 feet, are provided, three on one side of the building and two on the other. The principal toilet and locker room, equipped with hot and cold water and a shower bath room is located in a leanto on the north side of the foundry.

Italian Firm Designs An Electric Furnace

THE well known Italian automobile builder, the Fiat Corp., has decided to place on the market a new electric furnace which it has developed in its own shops during the past five years. The first of these furnaces was installed in the company's shop in 1917, and after it was put into operation new features were developed and other furnaces built and put into operation. With these furnaces the Fiat Corp. states it produced as high as 1000 metric tons of finished steel per month. Six furnaces of a capacity of between 5 and 6 metric tons have been built for the Fiat Corp. and six of 20 to 25 tons capacity are now being built for the Piedmontese Co., a subsidiary of the Fiat Corp. A number of furnaces also are being built for other Italian steel plants. One of the principal features of the Fiat furnace is the method of fitting the electrode holders to the top to prevent passage of air currents or flame, where the electrodes enter through the roof. With this arrangement it is claimed the electrodes are consumed more slowly, the lining of the furnace is preserved, and less power is lost while melting the steel. Also the claim is made that heats can be taken out more frequently.

The electrode stands which are designed to form a sealed closure around the electrodes can be operated to obtain the required movement of the electrodes by two screws placed in the grooves which guide the electrodes and which turn lugs fastened to the cover. The rotation of the screws is obtained through spiral gears connected to a small electric motor controlled by the operator on the platform.

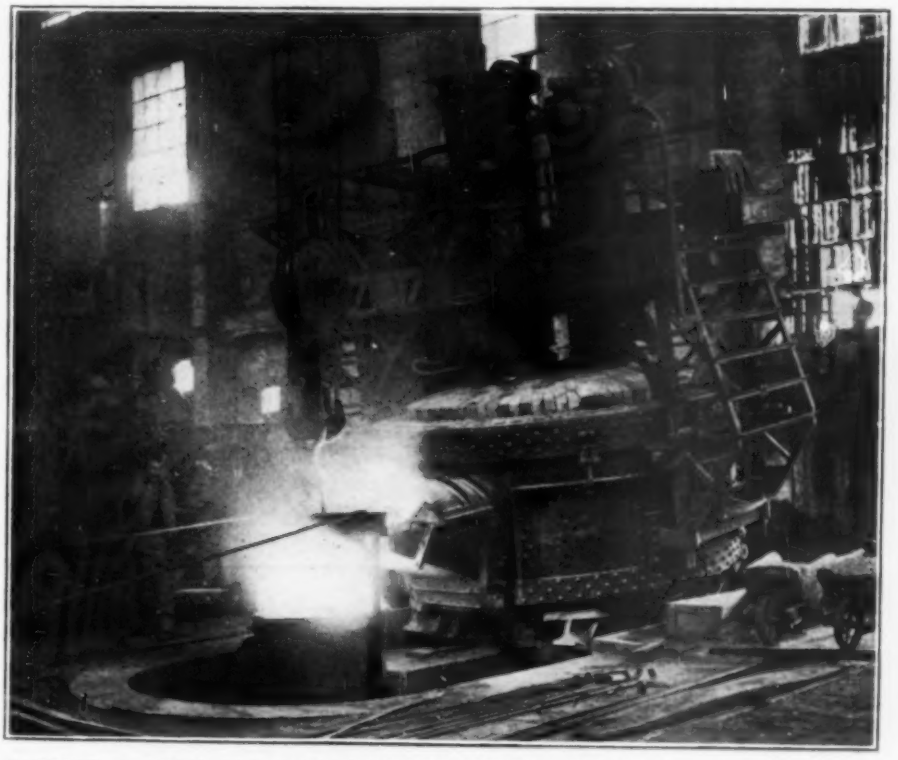
All parts are easily accessible for the ordinary maintainance and cleaning. The electrode stands each form a unit which can be easily moved and replaced by a crane without interfering with the furnace proper, as indicated in the accompanying illustration. The electrode holder with its sealing device can be applied to any other type of arc furnace with few changes.

The body of the furnace consists of a steel shell lined with three layers of refractories. The first layer is made slightly conductive to help carry current to the three collectors in the bottom as is explained later. The bottom and sides are made of dolomite. The roof is built of silica brick and normally lasts for 120 to 130 heats. The furnace is tilted on a rack by hydraulic power. Two doors are provided on opposite sides of the furnace for charging the metal.

Power is transformed to 130 volts for use in the furnace. The secondary connections of the transformers form a star, a different point of which is connected to each of the three electrodes. A cable from the center star of the transformer shielded with a flexible tube is fastened to the bottom of the furnace by bronze clamps, and is then grounded.

Three collectors are symetrically located under the lining in the bottom of the furnace under the electrodes, and are connected with a copper plate in the under layer of refractory material. The purpose of the copper plate is to facilitate the conductivity of the bottom by collecting the current on a large surface, and to moderate as much as possible the inevitable fluctuations of the current which take place between the start and the end of a heat.

The principal parts of the furnace are patented in the leading countries of the world and a specially designated department, Commercial Office for Fiat electric furnaces, Torino (4) Via Caserta No. 63 Italy takes care of the sales license, supervision of building and initial operation of the furnaces.



TAPPING A 6-TON ELECTRIC FURNACE—NOTE THE LADDER AND PLATFORM WHICH ENABLES THE WORKMEN TO REACH THE ELECTRODES

The Conemaugh Iron Works Co., a new corporation with offices at Latrobe, Pa. and a plant at Blairsville, Pa. has purchased the holdings of the Blairsville Iron Works. The new company will specialize in split ingot molds, stools and miscellaneous castings.

University To Instruct Foundrymen

The Claim Is Advanced That the Members of the Engineering Class Should Be Taught from a Technical Rather Than a Tradesman's Standpoint— Emphasizes Management Features

BY O. W. POTTER

WHERE are we going to get future mechanics, foremen, superintendents, engineers, in fact all trained foundry help. This question is becoming more insistent. The apprentice practically is a memory of the past and the mechanics in the making today, largely are specialists with absolutely no knowledge of the trade beyond a limited sub-division of one of the branches. Few molders today know anything of core making, sand mixing, furnace tending or making up the charge.

Without doubt, it is clear that the foundry industry must provide a system of education by which these necessary employes may be trained. The large company can take care of this through its own educational system. In fact it is being done by some large establishments, but even this method will become inadequate in the future when the demand for instruction surely will be increased. The small company finds it impossible to provide its own educational system. It is generally recognized that some sort of school or educational institution must be provided if the foundry industry is to prosper.

No branch of industry has been so neglected as the foundry. Methods have been pursued according to tradition and handed down theories. Colleges have provided education for every kind of engineer except the foundry engineer. Vocational schools have offered courses of instruction in every branch of woodcraft, drafting, machinery, tool making, automobile maintenance and repairing, but seldom is foundry practice taught. Even during the war while the government fostered almost every trade and profession, little attention was bestowed on the castings industry.

Practically the only place where any attention has been given foundry practice is in some of our colleges and technical schools. Where the engineer should be taught the foundry phases of engineering problems, the metallurgy of metals, general design and its relation to foundry troubles and economy of production, in the colleges he usually is taught a few facts strictly from a craftsman's standpoint. He is taught how to ram a mold, mix sand, charge the cupola and other manual features of the foundry business instead of being shown the real problems that face the engineer. Furthermore, foundry practice generally is taught in the freshman year before the student has had sufficient mathematics, chemistry and metallurgy to deal intelligently with foundry problems. The student spends from four to six hours a week for about 12 weeks on this subject, amounting in all to about the equivalent of six 8-hour days. One can imagine the value of such a course to a student who probably never before has been inside a foundry.

Night School Planned

An interesting movement started recently at the University of Minnesota, Minneapolis, by the Twin Cities Foundrymen's association contemplates a course in foundry practice to be offered in evening classes of the school. Primarily the object is to educate those now employed in the foundry industry to understand more about everyday foundry operation. Reasons are advanced for all processes formerly done by guesswork or luck, and the cause and effect of the various operations are explained. Foundry cost and materials will be gone into just enough to link everyday practice with desired results. A study of chemical and physical properties of foundry materials is to be made so that the employes handling them will understand their relative importance and also learn their proper use and specifications.

Selecting the proper type of instructor and providing adequate compensation for a man with the necessary qualifications, has an important bearing on this subject. One of the largest universities in the Middle West last year paid its foundry instructor $1100 for a full period of nine months, or at the rate of about $4.70 a day. What kind of instructors would be interested in a proposition of that character when foundry laborers at the same time were being paid $5 a day, or better, with employment all the year around; or where molders on the floor, with, in many cases, no qualification except a strong back, were earning from $7 to $15 a day? The result of this parsimony in some cases is an inefficient instructor. The job is likely to attract an old timer who has outlived his usefulness and is too old to hold down a regular floor in any shop. Again it may appeal to some foundrymen looking for a soft snap; or some inefficient mechanic who secures the position through influence. This condition does not always obtain, but under the meager salaries provided, the danger is present. Students taking the foundry course under such conditions do not get anything out of it; yet practically this is the only source of foundry education available.

The only other sources are the technical schools and a few correspondence schools fostered and prompted by some foundrymen realizing the great need of the industry.

The foundry problem from the engineer's standpoint recently was discussed with the faculty in charge of mechanical and metallurgical courses of a leading university which arrived at the following conclusions.

The present method of teaching foundry practice is quite inadequate.

The task of teaching an important branch of engineering should not be intrusted to inefficient instructors.

In a university dealing with prospective engineers the course should be conducted from a technical rather than from a tradesman's standpoint.

The course should not be taught with the idea of teaching the engineer how to perform the manual labor incident to foundry operation. It should be presented in a manner to show the relation of the foundry to engineering; foundry metallurgy in connection with strength of materials; foundry difficulties with reference to engineering.

The subject should be taught in the junior or senior year and after the young men have had advanced mathematics, chemistry and metallurgy.

This department should be handled under the metallurgical department instead of the mechanical engineering department.

The man in charge of the foundry department should be paid a minimum of $3500 for nine months and have the aid of competent assistants.

The foregoing conclusions were arrived at practically unanimously, but due to the radical departure from present practice it was left in abeyance, but

may come up again for final consideration at any time.

Metallurgical foundry knowledge usually is gained from hard knocks. The metallurgical courses in the schools all over the country deal with the metals from ore to raw material and then take up heat treating. They do not touch upon, or at best bear lightly, on the foundry process of converting raw material into a finished product. With a great school system throughout the country it seems as though we could bring pressure to bear and use the organization to teach foundry practice. All the foundries of the country and all the foundry organizations should think of this seriously and exert their influence upon the educational authorities to induce them to offer the subjects desired. There is no reason why our colleges, high schools and vocational schools should not be able to apply all the necessary educational facilities, including instructors, to handle all branches of the foundry industry. Probably this always will be supplemented by educational work in connection with all the larger industrial plants.

Educational Opportunity in Slack Times

At the annual dinner of the Sheffield branch of the Institution of British Foundrymen, held Jan. 27, Oliver Stubbs, Joseph Stubbs, Ltd., Manchester, president of the national organization of which the Sheffield branch is a part, said that foundrymen should carefully overhaul the equipment of their plants during the present period of slow business conditions, and where necessary install new and up-to-date machinery in order to be able later on to increase production and lower costs. Those foundries which are the best equipped and organized will participate first and most extensively in the business revival which is on the way, said Mr. Stubbs, adding that a comparatively small investment now in improved equipment will pay for itself handsomely later on when orders come thick and fast.

Mr. Stubbs also recommended carrying the policy of preparation a step further by opening the foundries on days they are now idle to employes for instructional purposes. Some British foundries have already adopted this policy. Lectures accompanied by practical demonstrations are given by the shop executives covering metallurgy, melting practice, molding, etc. In several districts a large number of men are taking advantage of this opportunity to extend their knowledge of foundry practice.

Such educational efforts, Mr. Stubbs pointed out, will make it possible later on for British foundries to make both better and cheaper castings, thus realizing the ideal of all good foundry managers, he said, which is to pay, not low wages but good wages for a fair amount of good work, management not being concerned with wage scales so much as with cost of production.

It was also announced at the dinner that the University of Sheffield expects to inaugurate a course of lectures on foundry practice dealing particularly with its metallurgical aspect. This course will be under the direction of Dr. Percy Longmuir and Dr. W. H. Hatfield.

Suggested Curriculum for Course in Foundry Practice and Management

(1) *Elementary drawing and blue print reading as applied to foundry practice. Figuring weights from blue prints and sketches. Checking patterns and coreboxes from blue prints. Standard conventions.*

(2) *Materials. Discussion of foundry materials, going briefly into the physical and chemical properties and touching on specifications.*

(3) *Elementary and foundry metallurgy. General discussion of various elements entering into the manufacture of castings, taking up both chemical properties and effect and final product. Sampling materials for analysis. Discussion of foundry metallurgical troubles. Figuring mixtures. Melting practice, including methods of charging, etc. Test bars and meeting specifications.*

(4) *Sands, refractories and fluxes. Discussion of physical and chemical properties and applications of various kinds of sands. Common refractories.*

(5) *Foundry economics. General discussion of defective castings. Cause and remedy. Melting losses. Using proper materials. Economical use of materials. Foundry refuse.*

(6) *Foundry machinery. Power, heating, air tools, molding machines, machines for cleaning castings. Discussion of various types in general and their care and maintenance.*

(7) *Foundry office work. Simple records, shop orders and instructions, simple cost records for shop purposes, estimates and quotations, shipping and receiving records.*

Book Review

Hendricks Commercial Register of the United States; cloth; 2324 pages, 8½ x 11½; published by S. E. Hendricks Co., Inc., and for sale by THE FOUNDRY; price $12.50 in the United States, and $15 in foreign countries, postpaid.

The 1922 edition of this book differs from those of previous years in that the size has been changed in the interest of readability. The new type size is 7 x 10 inches and more space has been allowed between lines and columns. In spite of the fact that the enlarged page accommodates 25 per cent more subject matter, the number of pages has not been decreased proportionately.

As in former editions, the book covers a wide range of industries and lists the manufacturers of equipment under many headings, including electrical, engineering, machinery, building, manufacturing, chemical, hardware, iron and steel, railroads, mining, quarrying architectural, etc. Dealers, manufacturers, producers and consumers are registered. At least 100,000 names of individuals and companies are classified by trades or products, and are indexed and cross indexed. A separate section furnishes references to distinctive products, listed by trade names or special brands. In another section the names of manufacturers are arranged alphabetically and their addresses and principal products are given.

Primarily the book is intended to be a guide for buyers and sellers and to this end the descriptive information of products and services is expected to assist in locating the sources of and outlets for finished materials.

Removes to New Offices

The Philadelphia office of the Hauck Mfg. Co., Brooklyn, manufacturer of oil burning torches, furnaces, etc., has been removed to 1726 Sansom street. Herbert Vogelsang is in charge.

The McQuay-Norris Mfg. Co., St. Louis, has acquired the plant and business of the Wainright Engineering Co., Connersville, Ind., manufacturer of piston rings.

Making Packard Auto Castings-II

The Cylinders Are Made Entirely in Dry Sand Molds, but Green Sand Both for Cores and Molds Has Been Adopted Successfully in Making All the Other Castings Required

BY PAT DWYER

NO ATTEMPT is made to recover any of the old core sand. The batches made up of sharp and bank sand in varying proportions bonded with an oil binder are prepared in a revolving mixer made by the National Engineering Co., Chicago. The interior cores, particularly the water-jacket cores which are entirely surrounded by metal and, therefore, must vent quite freely are made entirely from sharp sand; but the barrel cores, cover cores and pouring basins are made from a mixture of bank and core sand in the proportion of 2 to 1.

By referring to the illustration Fig. 9 showing a floor of assembled cylinder molds it will be seen that instead of a 3 or 4-part flask the mold is made up of a 2-part flask and a pair of covering flange cores. The cheek flask, provided with interior sand strips to support the sand is rammed on a rollover, jolt machine made by the Grimes Molding Machine Co., Detroit and the drag is rammed on a similar machine located a short distance away from the first molding machine.

The cheek flask is made the exact depth of part of the pattern. After the sand in the cheek is rammed, it is scraped off flush with the joint, covered with a sheet of paper, then with an iron plate, clamped and rolled over. After the drag is rammed it is scraped off flush with the bottom of the core prints, covered with an iron plate and rolled over. The patterns are drawn out of the cheek and drag after which the molds are sprayed with blacking, piled upon racks and taken to the ovens by automotive trucks. After the molds are dried, the drags are set on the floor with the bottom plates still attached, but the cheeks are lifted off the plates on which they were dried and rolled over before they are set on the drags.

Assembling the Mold

All the molding sand used for filling the cheeks and drags is mixed in a revolving pan equipped with a bucket loader. The flasks are close fitting and therefore the statement is not so extravagant as it may appear. The old sand is used repeatedly, mixed with a small quantity of new molding sand and a little sharp sand, the relative quantities of each depending on general conditions. A solution made by mixing a bucketful of dry core compound with a barrel of water is employed for giving additional bond to the sand. Usually about a quart to a wheelbarrowfull is sufficient.

One of the advantages claimed for vertically cast cylinders is that the various cores can be anchored in their prints without the use of chaplets. By referring to the drag of the mold containing the intake and exhaust core prints Fig. 13 it will be noted that the cylinder is cast in an inverted position to that it will assume when assembled in place on the chassis of the finished machine. A complete set of cylinder cores is shown in Fig. 10 and it may be well at this point for the benefit of those who may not be familiar with the molding problems involved in the production of these castings to indicate the name and purpose of each core. The core *A* simply is an open frame. It is placed on top of the assembled mold as shown in Fig. 9 and serves as a pouring basin. Cores *B* and *C* form the flange on the casting by which it is bolted to the crank case. These cores greatly simplify the molding of the cylinder, besides dispensing with two flask parts which under ordinary circumstances would have to be employed on this 4-part mold. The water-jacket core for the cylinder is made in two parts: the lower part is shown at *D* and the upper part at *E*. The six barrel cores are indicated at *F*, the exhaust cores at *G*, the two supplementary end core print cores at *H*, the intake cores at *I* and the four small

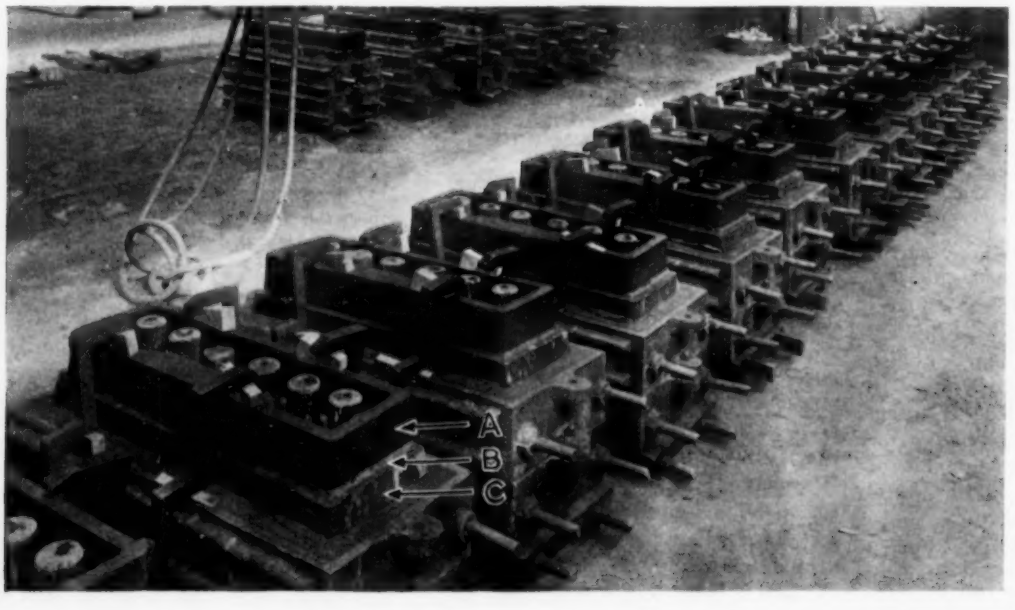


FIG. 9—TAPERED PRINTS IN THE COVER CORE FIT CLOSELY AROUND TAPERED SHOULDERS ON THE BARREL CORES AND HOLD THEM FIRMLY IN PLACE

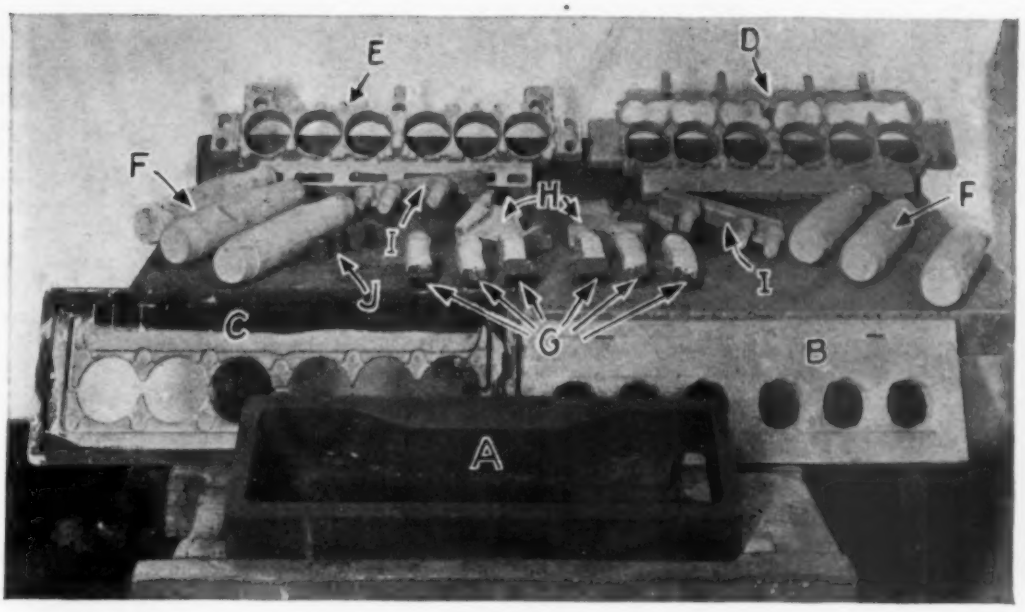


FIG. 10—A COMPLETE SET OF CORES FOR A 6-CYLINDER MOTOR COMPRISES 25 SEPARATE AND DISTINCT UNITS—THE WATER-JACKET CORE, SHOWN AT THE TOP, INVOLVES SOME NICE MANIPULATION IN RODDING AND VENTING—IT IS MADE AND DRIED IN TWO HALVES AND AFTERWARD ASSEMBLED AND PASTED IN THE MOLD

stop-off cores designed to fit over the four small round prints on the side of the water-jacket core are shown at *J*. Some of the different steps in closing the molds are illustrated in Figs. 9 and 13.

The drags, loaded on platforms are taken out of the oven and lifted onto gravity conveyors. Several men, depending on the desired output, stationed on both sides of the conveyor set the cores and keep pushing the flasks toward the end of the conveyor. Under present restricted operating conditions only the most skilled men have been retained and each man places the entire set of cores in a definite number of molds.

The end cores *H* really are the first cores to go into the mold, since they are placed in the cheek before it is placed in the oven. Their position is quite clearly indicated in one of the illustrations in Part 1 of this article, Fig. 4. However, in assembling the cores in the dried molds, the lower half of the jacket core is set first. This core rests on a generous print at each end and all along one side, and on four small prints on the fourth side and therefore requires no chaplets. The four, small, stop-off cores *J* are dropped into place over the round prints on the water jacket core. The six exhaust cores *G* then are set, followed by the upper half of the water-jacket core *E* and finally the intake cores *I*. A little paste is placed in each print before the cores are set and paste also is spread on the joints of the water jacket core. After the cores have been gaged for accuracy, minor repairs effected and given a coating of black wash, the entire assembly is placed back in the oven for about an hour to dry the paste and blacking. The

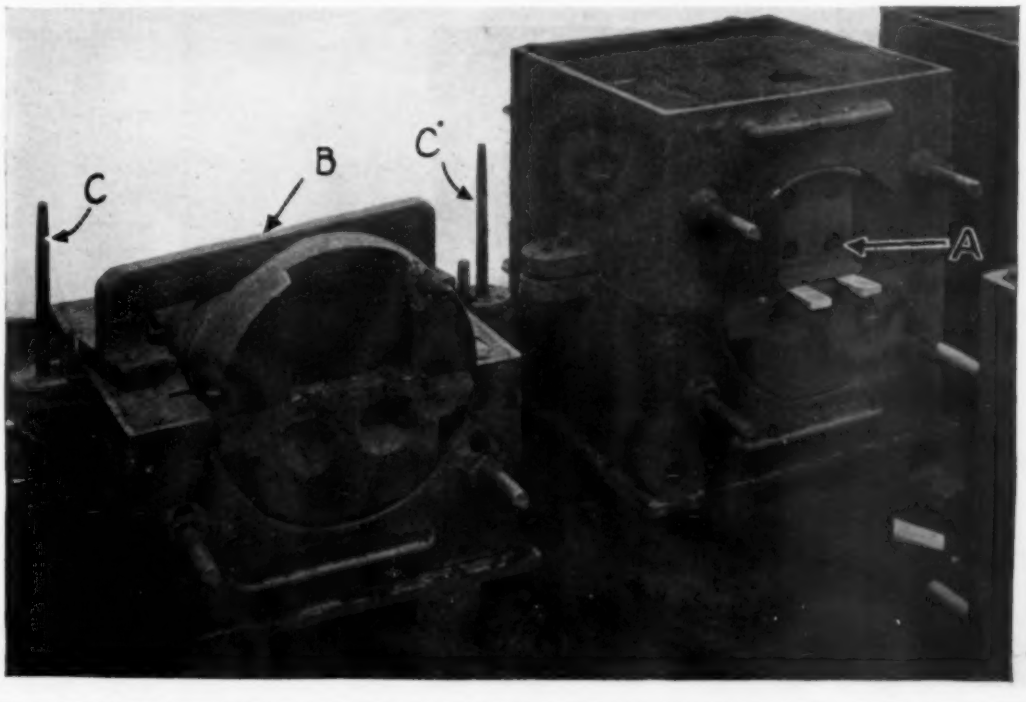


FIG. 11—THE STANDARD SHOWN AT *A* RESTING ON THE DRY SAND HALF OF THE CORE FURNISHES A READY MEANS FOR ANCHORING THE CORE IN PLACE

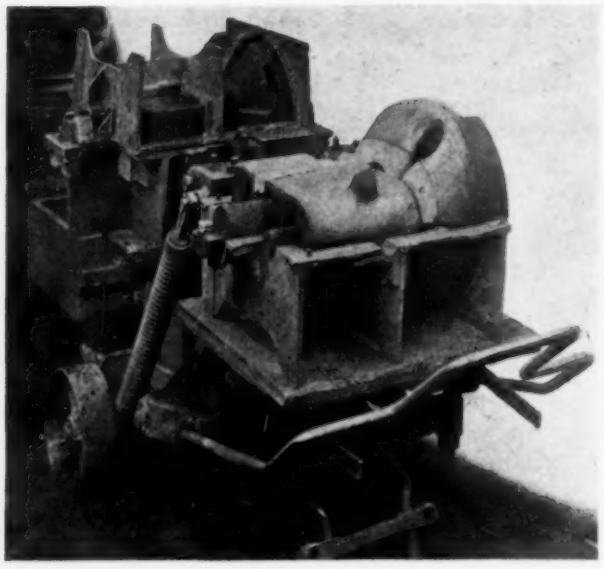


FIG. 12—THE ALUMINUM CRADLE SERVES AS A JIG IN LOCATING THE DRY SAND HALF OF THE CORE

tail is shown quite clearly in Figs. 1 and 13.

While the drag and assembled cores are drying, the cheeks are fitted with the covering flange core *B* Figs. 9 and 10 A thin film of paste is spread on the top joint of the cheek and then the core is set on, being guided into place by the combined senses of sight and feeling. The inner edge is exactly the same as the inner edge of the mold and the problem of getting the two edges to coincide is not particularly difficult. The inside edge is daubed with blacking and dried with a gas torch before the cheek is set on the drag. The cheek is guided into place by a tight fitting permanent pin at each end and then the barrel cores are lowered into place. The last core to be placed with the exception of course of the pouring basin, is the flat cover core *C*. It is located by a recess on the upper surface of the core *B*. This feature may be observed on several

rectangular openings in the long print at the back and also the two end prints of the upper half of the water jacket core, illustrated quite distinctly in Fig. 1 and 13, are provided to facilitate drying the paste between the two halves of the core. It is apparent that where the heat can circulate freely close to the paste, less time will be taken to dry the joint than where it is protected by a large solid body of sand. The gases from the water-jacket core are taken off through a vent scratched on the joint leading toward a number of openings in the back which in turn are connected with a number of grooves cut in the joint edge of the drag flask. This de-

FIG. 14—FLYWHEELS ARE POURED THROUGH A STRAINER GATE IN THE CENTER —THE CAST IRON CLAMPS TIGHTEN THEMSELVES AUTOMATICALLY

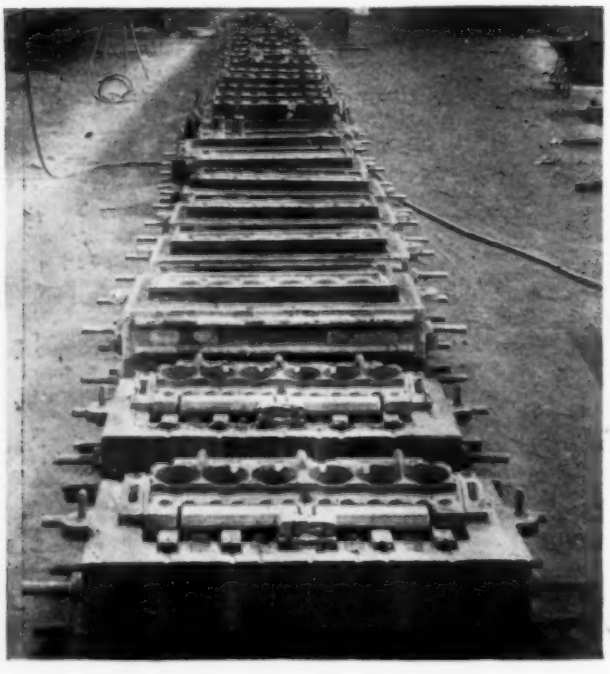


FIG. 13—PROGRESSIVE STEPS IN CLOSING THE CYLINDER MOLDS

of the partly closed molds in Fig. 13.

The barrel cores made long enough to extend through the cover core and up to the top of the pouring basin are provided with a tapered shoulder at the point where they pass through the cover core. The openings in the cover core are tapered at the same angle and fitting closely anchor the barrel cores securely in place. The iron is poured into the basin from a ladle at each end and enters the mold through six small flat gates surrounding each barrel. A floor of completed molds ready for pouring is shown in Fig. 9.

The cylinder head is molded in the manner illustrated in Figs. 6 and 7 in the preceding section of this article. Practically the entire mold is made in the cope. It is poured with two ladles from opposite ends, but on the same side as shown on the illustration. A number of small, flat gates connect the runner with the bottom face of the mold. The core is made in two parts. That part at the left, designed to form the pump chamber is anchored firmly in suit-

FIG. 15—SETTING THE CORES IN A CRANKCASE MOLD—THE CASTING IS POURED FROM OPPOSITE SIDES THROUGH TWO PAIRS OF HORN GATES

able coreprints, top and bottom and in turn, through an overhanging lip on the center bracket, serves to hold down the end of the water-chamber core. The flat core is supported in the drag by four prints on each side, each of which rests on a small dry sand block core provided with a suitable print. The core is held down by the four prints on each side, supplemented by the lip on the pump-chamber core and also by five radiator chaplets distributed as shown in Fig. 6. A small square piece of tin is laid in the shallow depression provided on the upper face of the core under each of the chaplets.

A gang of four men usually works on the transmission housing shown in Figs. 11 and 12. One man makes the drags on a rollover machine made by the Grimes Molding Machine Co., Detroit; a second makes the copes on a jolt stripping machine made by the Osborn Mfg. Co., Cleveland; while a third workman puts the green-sand tops on the cores and the fourth man sets the cores and prepares the molds for casting. The lower half of the core and a few over-hanging parts of the top half are made of dry sand in the usual

FIG. 16—SET OF COREBOXES AND ARBORS USED IN MAKING THE GREEN SAND CORES FOR THE CRANKCASE—APPROXIMATELY HALF AND HALF NEW AND OLD MOLDING SAND, PROPERLY TEMPERED, IS USED FOR THESE CORES

manner. The upper half of the core is made in green sand in an iron corebox. The sand is rammed gently, butted, scraped off flush with the joint, vented and then the dry sand half is set on so that the joint coincides all around. An aluminum frame provided with locating pins is set over the dry sand half core and clamped. This frame, shown in position before and after the core is rolled over, in Fig. 12, not only insures that the two halves of the core will be definitely and properly jointed and prevented from shifting when rolled over, but also serves as a cradle to carry the completed core to the mold. A heavy cast-iron arbor in the dry sand half of the core furnishes a ready means for anchoring the core as illustrated at *A*, Fig. 11. The gage shown at *B* is tried over each core after it has been lowered in place and the special long guide pins shown at *C C* are employed for guiding the cope into place. These pins are removed after the cope is closed, but the regular permanent pins remain and prevent the flasks from shifting through any cause. The casting is poured through a basin formed in one end of the cope connecting with two upright runners, one on each side of the casting. A single riser is taken off the high end.

Molding Other Parts

Molds for flywheels illustrated in Fig. 14 are made on a pair of jolt, squeeze and strip plate machines made by the Osborn Mfg. Co., Cleveland. The method of gating through a perforated center core, pouring, and clamping the flasks are shown in detail in the illustration and require no comment. It is claimed that on this particular job the loss from all causes runs less than one per cent.

The brakeshoes shown in Fig. 17 furnish another interesting example of green sand molding. Formerly this pattern was made solid with four large core prints on the outside. Dry sand cores were placed in the mold to form the ribs on the back of the brakeshoes. Two new patterns and plates were made as shown in the illustration and mounted on a pair of hand-ram, rollover machines made by the International Molding Machine Co., Chicago. The cope pattern was cut across four ways as shown by the piece *P* and the four loose pieces thus produced stay in the mold after the main part of the pattern is drawn. They then are drawn in toward the center of the mold and placed back on the pattern for the following mold. In addition to the wide seat provided on the pattern for each loose piece, a pin, *O*, supports the projecting lug while the sand is being rammed under and around it.

The aluminum crankcase for the six cylinder engine is made entirely in green sand. Besides effecting economies by eliminating the need of mixing binder with the sand, and fuel for drying the cores, the green sand cores yield readily to the contraction of the casting and remove the danger of cracks and distortion. A set of coreboxes, open to show the arbors in place, and also several of the cores as they appear ready to be placed in the mold are shown in Fig. 16 The bolts and the method for handling and setting the cores are shown in Fig. 15. The bolts are not removed until the entire set has been placed. The molds are made on three large rollover machines, one made by the Tabor Mfg. Co., Philadelphia, and two by the Osborn Mfg. Co., Cleveland.

Metals enters below through two pairs of horn gates as shown at the right in Fig. 15 and eight large risers are provided on the top to compensate for shrinkage. Another advantage claimed for the green sand cores is the ease with which they may be removed from the casting. After the castings are taken to the shakeout station, a steel bar, attached to a pneumatic vibrating device, is employed to loosen the sand which falls out quite readily and leaves the casting clean.

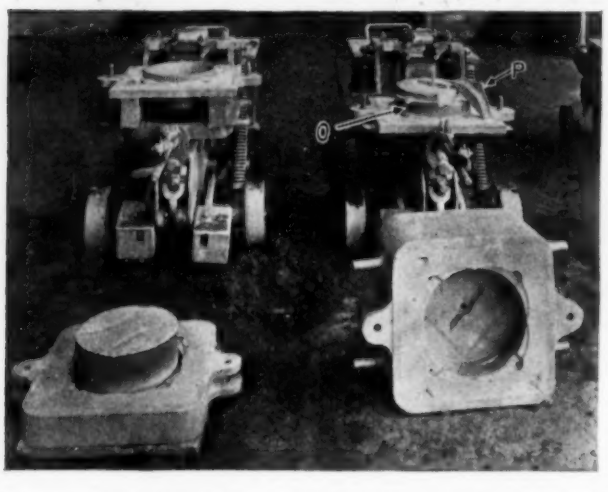


FIG. 17—THIS BAND AFTERWARD SAWED APART TO MAKE FOUR BRAKE SHOES IS MOLDED ENTIRELY IN GREEN SAND

Preparing at Birmingham

The arrangements for the international foundry exhibition to be held in Bingley hall, Birmingham in June next are approaching completion. The first meeting of the technical advisory committee was held on Jan. 30 when a comprehensive program was considered. A feature of special interest will be a model foundry completely laid out and arranged for work. All the operations of the foundry will be shown with the exception of cupola melting. Some 16 firms will contribute various items of plant and machinery showing sand mixing, jolt ramming, machine molding and pressing, sand blasting and similar operations illustrative of the latest foundry practice.

Another interesting feature of the Birmingham exhibition will be a competition in patternmaking open to foundry employes in which many prizes with diplomas are offered. This is expected to attract keen competition. The patterns are to be made previously, and the prizes will be awarded for the best exhibits.

A historical section chiefly furnished by technical societies and universities will show ancient molding and casting from the beginning of foundry history. In this department assistance has been rendered by about 70 donors.

The exhibition of die-casting apparatus is expected to develop a certain amount of emulation between Birmingham, which has always been distinguished in this line and Sheffield, London and other metal working centers.

The Institution of Automobile Engineers is putting forward the date of its summer meeting to make it coincide with the Birmingham exhibition, and it is intended to make the arrangements fit in with the general program. This is an important body having its headquarters in London, with a membership of 1500. Several other technical societies are considering the advisability of following this example.

The W. W. Sly Mfg. Co., Cleveland has relocated its eastern district sales office at 120 Liberty street, New York. D. P. Carter now is in charge of this district having succeeded D. E. Hadley who recently resigned. The company is represented in the Philadelphia district by J. Jacob Shannon & Co.

Studies Reactions in Malleablizing

Effect of Different Temperatures and Length of Anneal Shown by Micrographs—Samples Quenched After Being Held at Annealing Temperature for Various Lengths of Time

BY ARTHUR PHILLIPS AND E. S. DAVENPORT

CERTAIN data and observations resulting from a series of experiments dealing with the heat treatment and microstructure of commercial white cast iron and its derivative, malleable iron are worthy of study. In planning the experimental work, particular care was used to secure for the tests white cast iron of *normal* composition; i.e., within the composition limits commonly prescribed by manufacturers of malleable castings. A review of the literature leads us to believe that much data of a fragmentary character treating of the graphitization of white cast iron have been of little value, mainly because of the diversity in chemical composition of the materials employed in the tests. Moreover, when feasible, annealing periods at least comparable to those of current practice have been adopted.

We wish to acknowledge our indebtedness to the members of the research department of the Eastern Malleable Iron Co. for the white cast iron used in the tests and, particularly, for their active co-operation during the experimental stage of the work.

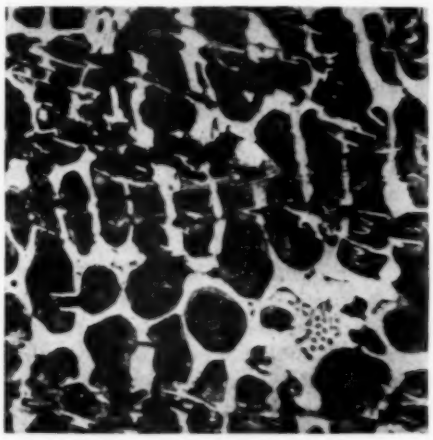


FIG. 1—NORMAL WHITE CAST IRON—X 250 DIA.

Scope of Study

In this paper the following subjects are discussed in the order indicated: Data on the thermal critical points of white cast iron and malleable iron; changes produced in tensile properties and microstructure of white cast iron by annealing at different temperatures within the range, 760 to 1100 degrees Cent.; relation of thickness of wall section of hard iron to microstructure and tensile properties of malleable iron obtained under normal annealing conditions; notes on mechanics of graphitization of normal white cast iron as observed in specimens quenched after various periods of anneal at approximately 800 degrees Cent.

The American *malleableizing* process consists essentially of a lengthy heat treatment at a moderately high temperature, followed by extremely slow cooling, with the object of converting the cementite of the white cast iron into graphite, or *temper* carbon, and ferrite. From the physicochemical point of view, the changes involved during this treatment are extremely complicated and are not thoroughly understood at the present time. Typical white iron structures are shown in Figs. 1 and 2; Fig. 3 is representative of normal *black heart* malleable.

The exact temperature at which temper carbon begins to form has been greatly disputed. Some investigators believe that the change is initiated at, or slightly above, the A_1 point; others hold that graphitization can take place below the lower critical temperature. This point is discussed elsewhere in this paper and some experimental results bearing on the subject are offered.

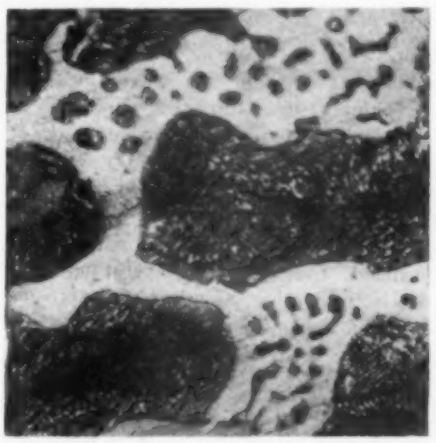
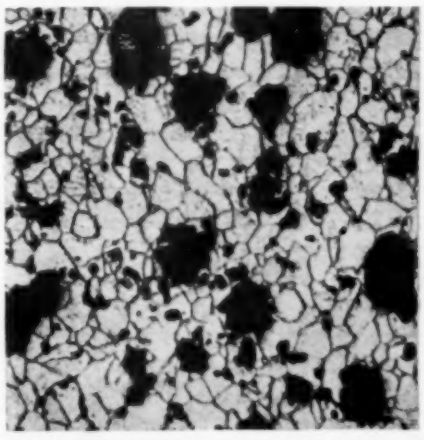
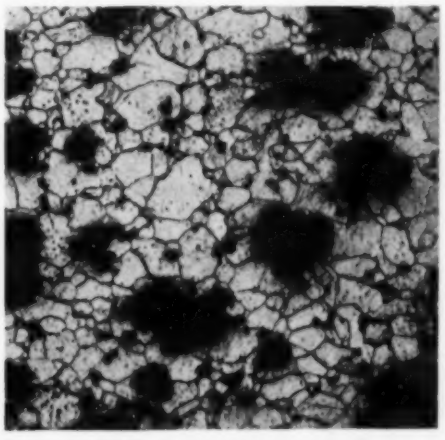


FIG. 2—LEDEBURITE IN WHITE IRON—X 750 DIA.

As it is generally assumed that the

Metallographic communication from the Hammond laboratory of the Sheffield Scientific school, Yale university, presented at the February meeting of the American Institute of Mining and Metallurgical Engineers, held in New York. Mr. Phillips is assistant professor of metallurgy, Sheffield Scientific school, Yale university, and Mr. Davenport is research engineer, Eastern Malleable Iron Co., Naugatuck, Conn.





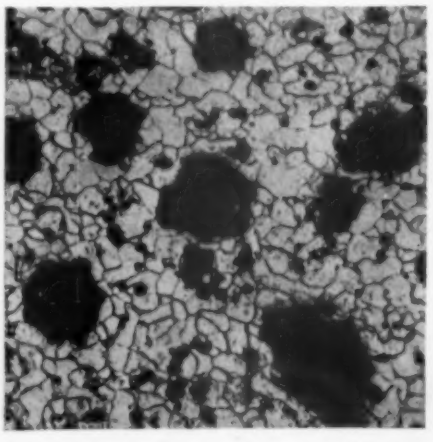


FIG. 3—NORMAL MALLEABLE CAST IRON—X 100 DIA. FIG. 4—ANNEAL I—HOTTEST POT IN OVEN FIG. 5—ANNEAL II—COOLEST POT IN OVEN

Unless otherwise noted all specimens etched with 5 per cent nitric acid in alcohol

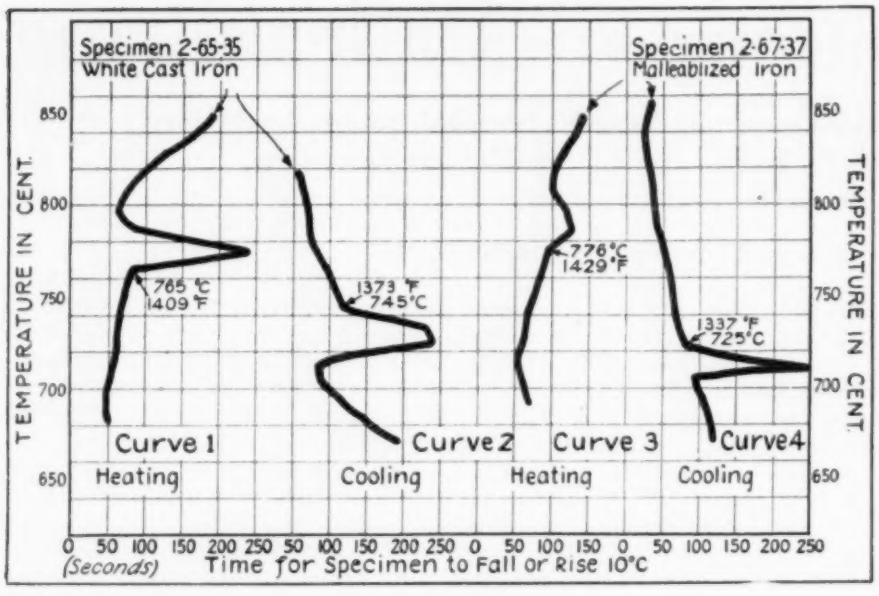


FIG. 6—CRITICAL-POINT CURVES

temperature of initial precipitation of temper carbon is approximately the lower critical temperature of the material in question, it seems desirable to have precise information regarding the Ac_1 and Ar_1 points of normal hard iron. The literature records the results of a number of investigators who have determined the critical temperatures of cast iron covering a wide range of composition; Table I summarizes what seem to be the most significant and valuable data available.

The results of Schwartz and Bean are of especial interest ts they were obtained presumably by Schwartz and without doubt by Bean, on material of normal composition from the viewpoint of the manufacture of malleable castings. Schwartz's results, admittedly, were lacking in precision, and undoubtedly are low; Bean's values are fairly consistent with the results of earlier investigators, particularly Hague and Turner.

In order to obtain additional data, the writers made careful determinations on white cast iron and commercial malleable iron; the malleableized specimens showed no combined carbon and apparently had been properly and thoroughly annealed. The specimens were of the following compositions:

	White cast iron Per cent	Malleable iron Per cent
Sulphur	0.083	0.108
Manganese	0.30	0.28
Phosphorus	0.160	0.193
Silicon	0.90	0.81
Total carbon	2.40	2.35

The specimens were taken from the central portions of standard American Society for Testing Materials tensile bars, and had holes into which the hot junction of a platinum-platinum, rhodium thermocouple, in series with a high-resistance galvanometer was inserted. An electric resistance muffle furnace was used in these and in all laboratory annealing treatments described here. Inverse-rate heating and cooling curves are shown in Fig. 6 and the critical points Ac_1 and Ar_1 taken as the temperatures corresponding to the beginning of the break in each curve, reading from bottom to top in the case of heating and from top to bottom in the case of cooling.

Interpreting Results

Difference of opinion exists as to the proper interpretation of critical-point data from inverse-rate curves. Some writers believe the peak of the break should be taken as the true value for the point, others argue that the beginning of the break should be taken. We are inclined to agree with Howe that the first inflection in the curve, that is, the beginning of the transformation, should be regarded as the significant temperature. This interpretation enables us to compare our results directly with those of Bean which with the curves in Fig. 6 show that our results agree closely. In our opinion 745 degrees Cent. may be regarded as the Ar_1 point for hard irons cooled at the rate of approximately 1 degree Cent. per second.

As, however, the rate of cooling (4 degrees to 5 degrees Cent. per hour) found imperative in malleableizing practices extremely slow and the temperature of anneal (approximately 780 degrees Cent.) does not greatly exceed the Ar_1 point determined under ordinary conditions, it is conceivable that the real and significant critical point is more nearly Howe's Ac_1 temperature, that is, some temperature between the Ar_1 and Ac_1 points as indicated by the conventional cooling-curve determinations. It is interesting to note that Archer[1] believes that "for a 1.0 per cent silicon iron, the A_1 point is probably within 15 degrees Cent. of 750 degrees Cent."

It may be noted that, in both sets of results, the gap between Ac_1 and Ar_1 is much greater in the case of the malleableized specimens than in the case of the white cast iron. An examination of the curves, Fig. 6, show that the thermal effect, as shown on the heating curve of the malleableized specimen, is small. This can be explained on the basis of the theory that it is only the combined carbon which takes part in the transformation A_1. In the malleableized specimens, the combined carbon content was extremely low, in fact, so low that no cementite could be detected under the microscope at ordinary magnifications. The relatively large amount of temper carbon, while having little effect on the Ac_1 transformation, did have a decided effect on the Ar_1 point of the same iron. At some temperature near the Ac_1 point, probably Ac_1 exactly, the iron began to dissolve some of the temper carbon, absorbing more and more as the temperature was raised. Upon cooling at a relatively rapid rate, this dissolved carbon did not have time to precipitate again as temper carbon, but came out of the solution as combined carbon in the form of pearlite, with possibly a small amount of pro-eutectoid cementite. Thus, we would ex-

[1] R. S. Archer: Graphitization of White Cast Iron. Issued with Min. & Met., as section 10 (February, 1920).

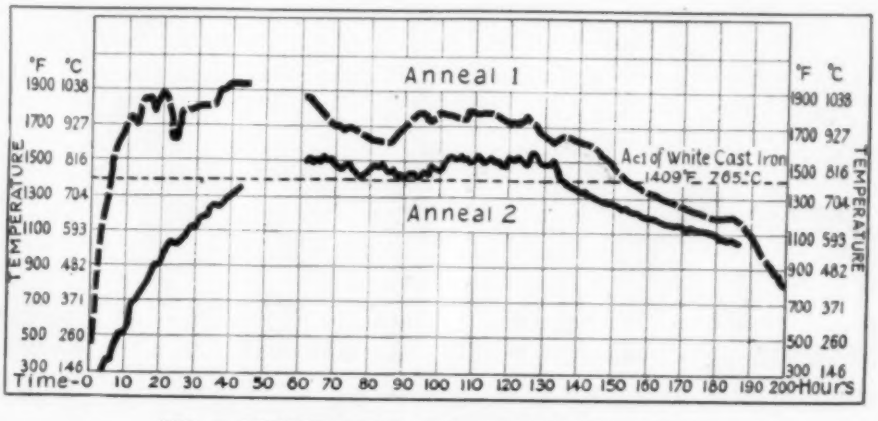


FIG. 7—TEMPERATURE RECORD OF SHOP ANNEAL

Table I
Critical Temperatures of Cast Iron

Ar_1 Point, Degrees Cent.	Ac_1 Point, Degrees Cent.	Carbon content, Per cent	Silicon content, Per cent	Observers
740-750	...	3.96	1.14	Wust and Peterson *a*
726	...	2.95	0.68	Hague and Turner *b*
730	...	2.56	0.97	Hague and Turner *b*
734	...	2.70	1.19	Hague and Turner *b*
700	715	2.00	1.1	Charpy and Cornu-Thenard *c*
693	732	Not given	Not given	Schwartz *d*
746	763	2.58	0.87	Bean *e*
745	765	2.40	0.90	Hammond Laboratory

a Wust and Peterson: Beitrag zum Einfluss des Siliciums auf das System Eisen-Kohlenstoff, Metallurgie (1906) 3.
b Hague and Turner: Influence of Silicon on Pure Cast Iron. Jnl. Iron and Steel institute (1910) 82.
c Charpy and Cornu-Thenard: Researches on Iron, Silicon and Carbon Alloys. Jnl. Iron and Steel institute (1915) 91.
d H. A. Schwartz: Some Physical Constants of American Malleable Cast Iron. Proc. Amer. Soc. Test. Mat. (1919) 19, Pt. 2, 247.
e W. R. Bean: Discussion of Schwartz' paper.

pect a greater thermal effect on the cooling curve than on the heating curve, which is the case. The re-solution of free carbon upon heating graphitic irons above A_1 has been conclusively shown by other investigators, notably Touceda[2] and Archer.[3]

This series of experiments was begun primarily to determine the effect of variation in temperature, of the order commonly found in commercial annealing furnaces, on the structure and tensile properties of the completely malleableized product.

High Temperature Reduces Strength

It has long been known that extremely high temperatures will cause so-called burned castings, the characteristics of which are excessive decarburization, intercrystalline oxidation near the surface of the casting, a reduction in strength and ductility and a general deterioration of the product. Fortunately, these extremely high temperature anneals are rare. However in the commercial oven of average dimensions, a pronounced thermal gradient exists, so that castings nearest the firebox reach a much higher temperature and have a longer annealing period than those at the opposite end of the oven. For this reason, they might show quite different tensile properties and microstructure.

Occasionally, castings of normal chemical composition and apparently normal heat treatment yield poor tensile properties; the microstructures appear to be normal in most cases, except possibly for a somewhat coarser ferrite and temper-carbon structure. It has long been a question as to whether the coarser structures could be associated with the poor physical properties of these castings and whether such structures had been caused by a high-temperature anneal; that is, a temperature not high enough to *burn* the castings but high enough to modify the mechanical properties. White and Archer[4] have shown that high-temperature anneals tend to coarsen the temper-carbon nodules and cause a deterioration in mechanical properties. However, they did not show how the ferrite matrix, which is the main body of the casting, was affected by the higher temperature, nor did they offer data correlating deterioration in tensile properties with high-temperature anneals. It has always been assumed that the coarse structures of malleable iron are due to high annealing temperatures. Except the work mentioned, so far as we are aware, no investigations on the subject have been reported.

In order to determine the magnitude of the thermal gradient in a commercial annealing oven and, more particularly, to furnish data associating differences in microstructure and tensile properties with such temperature variation, the following heat treatments were carried on. The material used consisted of a set of 30 standard American Society for Testing Materials tensile test bars cast from a regular foundry heat. The fracture of the material as cast was clear white and perfectly normal in all respects. Its composition was silicon 0.90 per cent, manganese 0.30 per cent, sulphur 0.083 per cent, phosphorus 0.160 per cent, total carbon 2.40 per cent.

Anneal I—Four bars were packed in the hottest pot of a commercial annealing oven of average dimensions—11 x 16 x 8 feet high to spring of arch; firebox in corner, 9 square feet of grate. Briefly stated, they were annealed *top pot*, firebox. An iron-constantan thermocouple was placed in the furnace in such a way that the end of the protecting tube was in direct contact with the pot containing the bars.

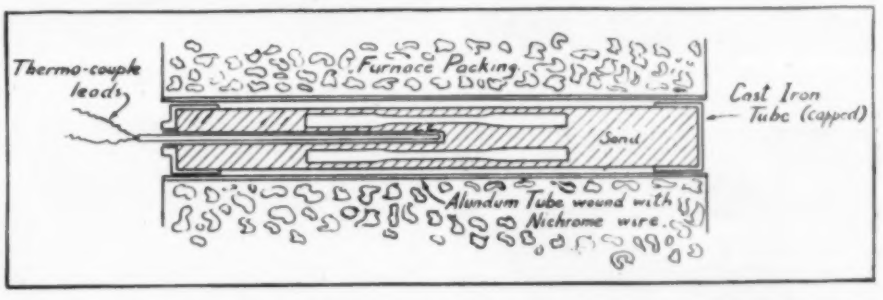


FIG. 8—POSITION OF BARS IN FURNACE RELATIVE TO THERMOCOUPLE

Anneal II—Four bars were packed in a similar manner in one of the coolest pots in the same furnace; that is, they were annealed in a pot at the opposite end of the furnace, or in the *bottom pot, from middle*. A thermocouple also was placed in this end of the furnace, the hot junction end of its casting being in direct contact with the pot containing the bars. Both thermocouples were connected to an automatic temperature recorder. The furnace was charged as usual, fired for five days, and then allowed to cool at the rate of about 4 degrees Cent. per hour; in other words, the material was given a normal anneal. Curves I and II, Fig. 7, are the

[2] E. Touceda: Research on Malleable Iron. Trans. Am. Soc. Mech. Eng. (1919).

[3] Loc. cit.

[4] A. E. White and R. S. Archer: Annealing of Malleable Castings. Trans. Amer. Foundrymen's Assn. (1918) 27.

Table II
Bars Annealed in Various Parts of Oven

Anneal number	Bar number	Diameter, Inch	Yield point, Pounds per square inch	Ultimate strength, Pounds per square inch	Elongation in 2 inch, Per cent	Remarks
I	1	0.637	36,242	52,747	14.0	Annealed in hottest pot
I	2	0.639	35,609	52,299	14.0	
I	3	0.636	35,616	54,865	16.5	
I	4	0.649	35,821	52,431	14.0	
Average			35,822	53,063	14.6	
II	1	0.643	38,771	53,738	18.5	Annealed in coolest pot
II	2	0.640	39,602	51,911	11.5	
II	3	0.634	38,248	55,020	15.5	
II	4	0.637	37,495	54,457	12.5	
Average			38,529	53,782	14.5	

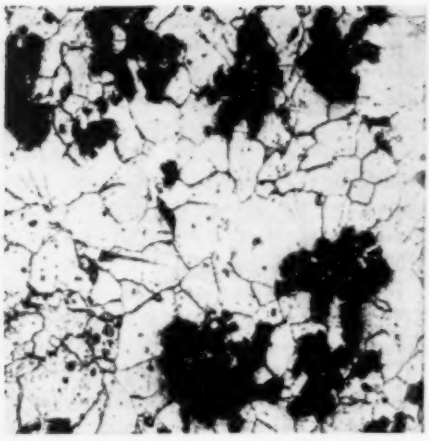


FIG. 9—ANNEAL III—55 HOURS AT 1100 DEGREES CENT.—X 100 DIA.

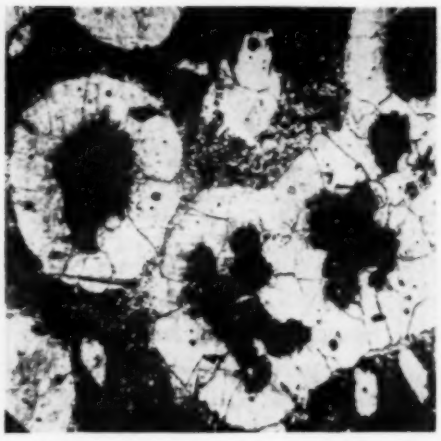


FIG. 10—SAME AS FIG. 9, COOLED RAPIDLY—X 100 DIA.

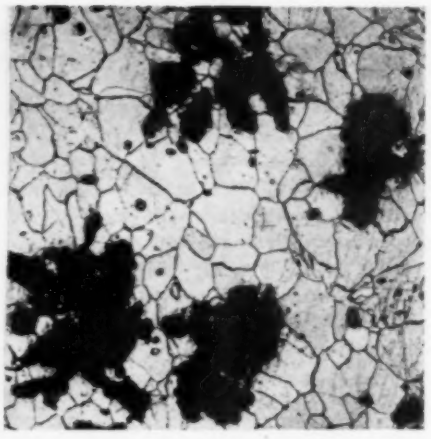


FIG. 11—ANNEAL IV—60 HOURS AT 1100 DEGREES CENT.—X 100 DIA.

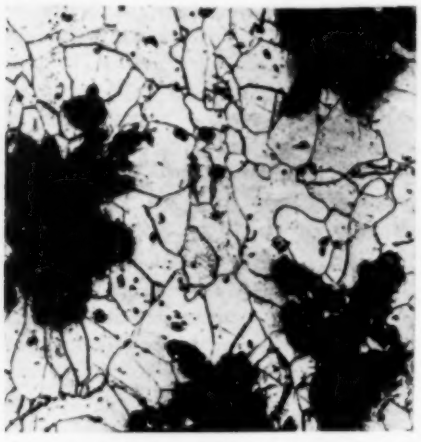


FIG. 12—SAME AS FIG. 11—NOTE THE IRREGULAR TEMPER CARBON

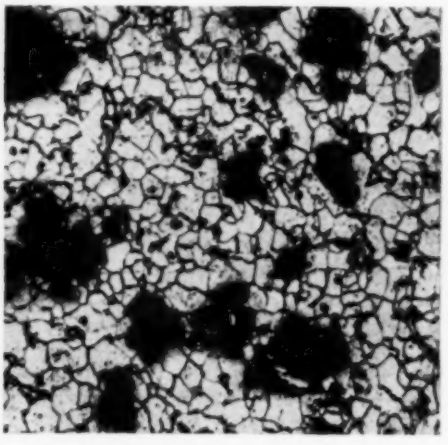


FIG. 13—ANNEAL V—63 HOURS AT 785 DEGREES CENT. X 100 DIA.

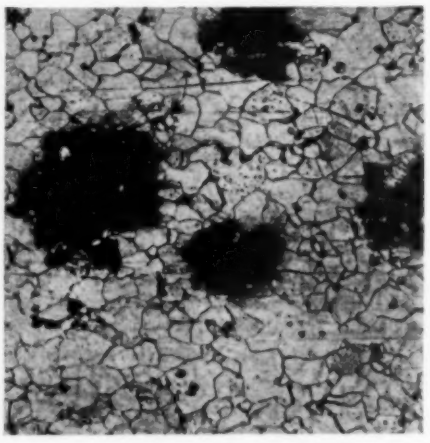


FIG. 14—ANNEAL VI—70 HOURS AT 830 DEGREES CENT.—X 100 DIA.

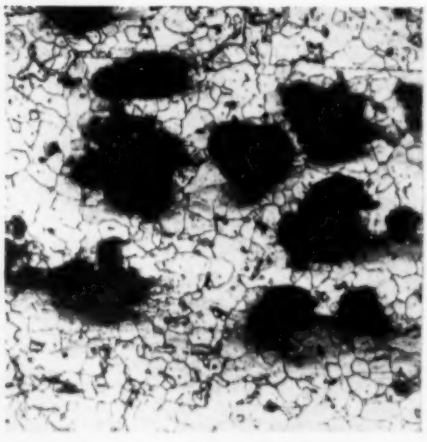


FIG. 15—ANNEAL VII—93 HOURS AT 770 DEGREES CENT.—X 100 DIA.

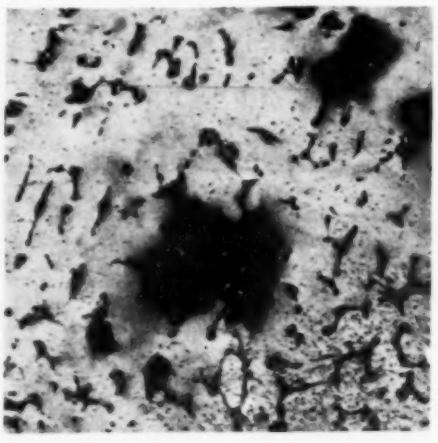


FIG. 16—SAME AS FIG. 15—ETCHED WITH SODIUM PICRATE—X 100 DIA.

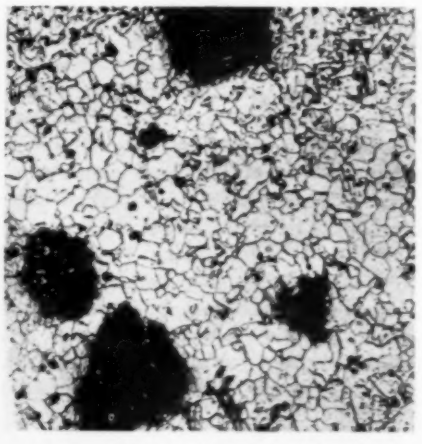


FIG. 17—ANNEAL VIII—121 HOURS AT 770 DEGREES CENT.—X 100 DIA.

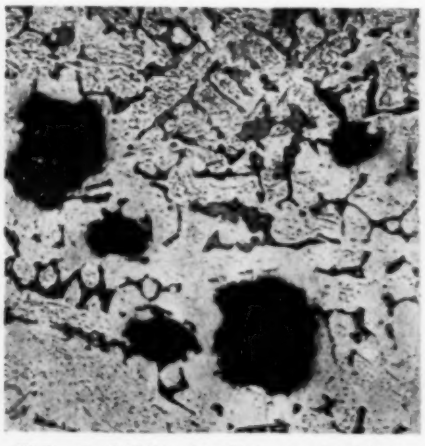


FIG. 18—SAME AS FIG. 17—ETCHED WITH SODIUM PICRATE—X 100 DIA.

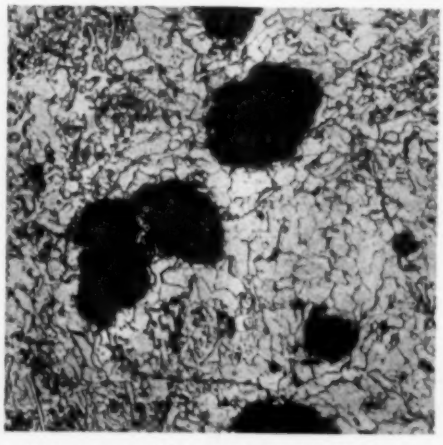


FIG. 19—ANNEAL IX—98 HOURS AT 750 DEGREES CENT.—X 100 DIA.

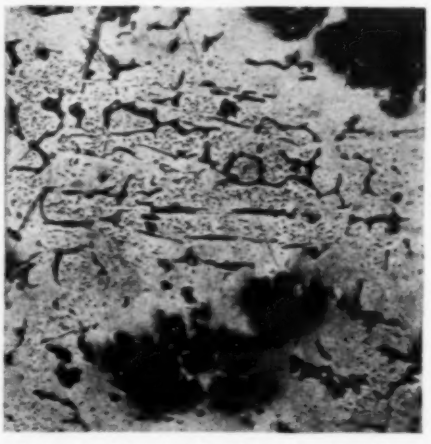


FIG. 20—SAME AS FIG. 18—ETCHED WITH SODIUM PICRATE—X 100 DIA.

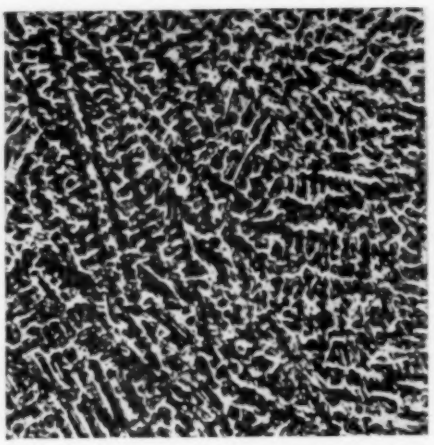


FIG. 21—WHITE CAST IRON—X 100 DIA.

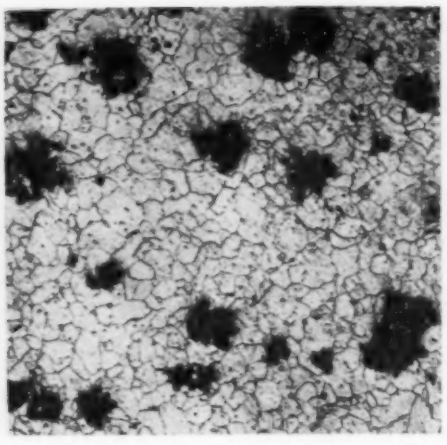


FIG. 22—SAME AS FIG. 21—ANNEALED—X 100 DIA.

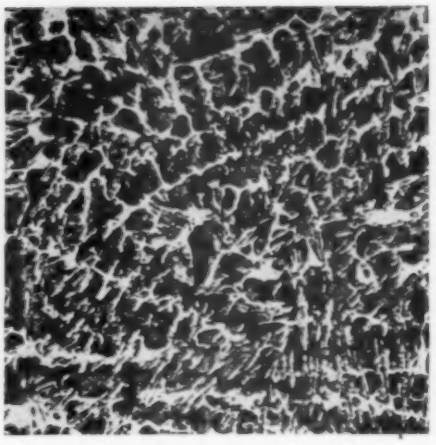


FIG. 23—WHITE CAST IRON—X 100 DIA.

temperature records of the hottest and coolest pots, respectively. The break in each curve was caused by the recorder mechanism getting out of adjustment one night. However, it is concluded that at no time during this interval did the temperature get above the maximum temperature recorded by the instrument. After the oven had reached the annealing temperature, a difference of about 140 degrees Cent. between the hottest and coolest sections was recorded. The bars of anneal I were above the critical range for about 150 hours, while the bars of anneal II were above it for about 85 hours.

The results of the tensile tests are summarized in Table 2. It is evident that a thermal gradient of the order encountered in this anneal, which may be regarded as representative of current practice, has little or no significance if the ordinary tensile test is regarded as a criterion of quality. All tests successfully met the American Society for Testing Metals specifications.[2] Fig. 4 shows the structure of the material annealed at the higher temperature and Fig. 5 the structure of the iron annealed at the lower. Although there is apparently little or no difference in the size of the temper-carbon areas produced, there seems to be a difference in the physical condition of the graphitic masses; the graphite in Fig. 5 is more compact and more sharply outlined than in Fig. 4. The higher temperature has apparently produced a somewhat coarser ferrite matrix.

[2]Specifications; Tensile strength 45,000 lb. per sq. in. (3163.9 kg. per sq. cm.); elongation in 2 in. 7½ per cent.

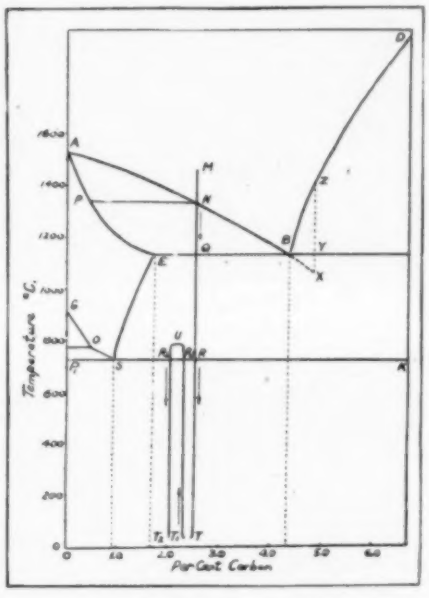


FIG. 27—IRON-CARBON EQUILIBRIUM DIAGRAM

The differences in both the tensile properties and the microstructures of the two sets are so slight we conclude that, in spite of the marked temperature gradient and the considerable difference in time above Ac_1 castings annealed in a commercial furnace under such conditions will be of reasonably high quality.

Annealed in Laboratory

In order to determine the effect of annealing temperatures covering a range not usually encountered in a commercial oven, several lots of bars were annealed in the laboratory.

Anneal III—High temperature (1100 degrees Cent.)—Two bars were packed in sand in a cast-iron tube, capped at both ends, 23 inches long and 2½ inches in diameter. A thermocouple, enclosed in a thin platinum-platinum, rhodium iron casting, was inserted through one end of the tube in such a manner that the hot junction was between the bars at a point midway between their ends, as shown in Fig. 8. The tube was placed in an electric resistance muffle furnace of suitable dimensions consisting essentially of an alundum tube wound

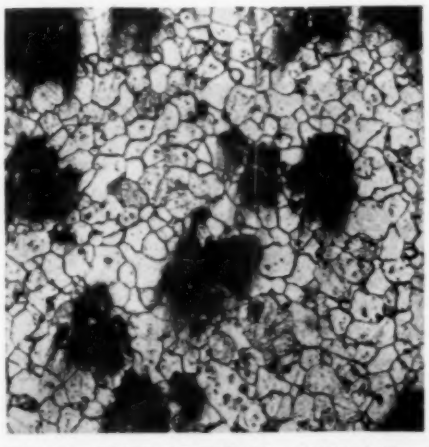


FIG. 24—SAME AS FIG. 23—ANNEALED—X 100 DIA.

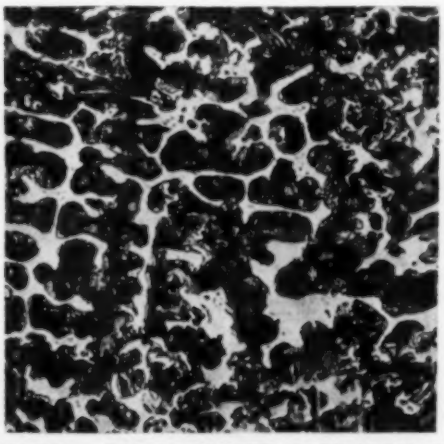


FIG. 25—WHITE CAST IRON—X 100 DIA.

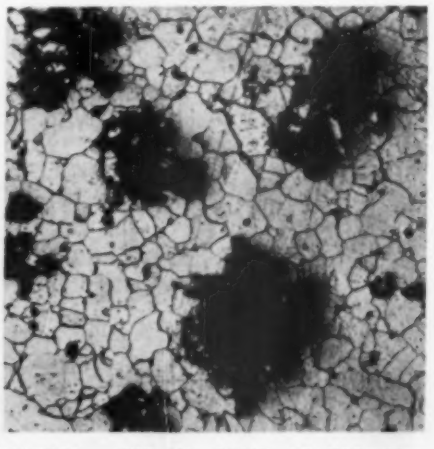


FIG. 26—SAME AS FIG. 25—ANNEALED—X 100 DIA.

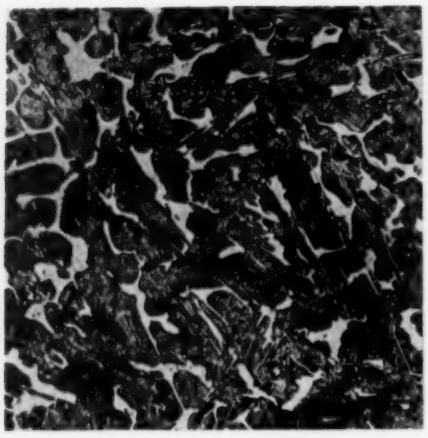


FIG. 28—QUENCHED AFTER REACHING 800 DEGREES CENT.—X 100 DIA.

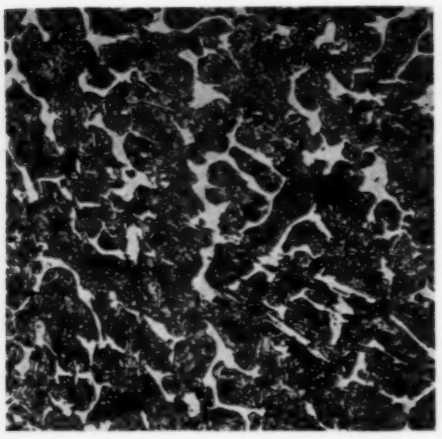


FIG. 29—QUENCHED AFTER 3 HOURS AT 800 DEGREES CENT.—X 100 DIA.

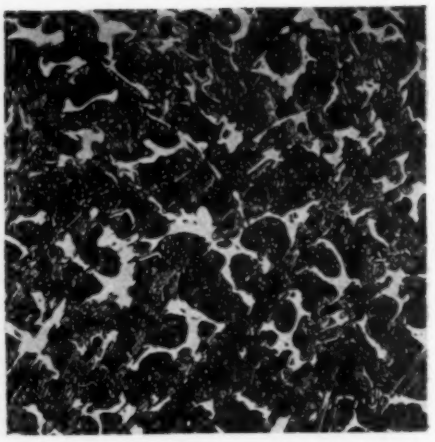


FIG. 30—QUENCHED AFTER 8 HOURS AT 800 DEGREES CENT.—X 100 DIA.

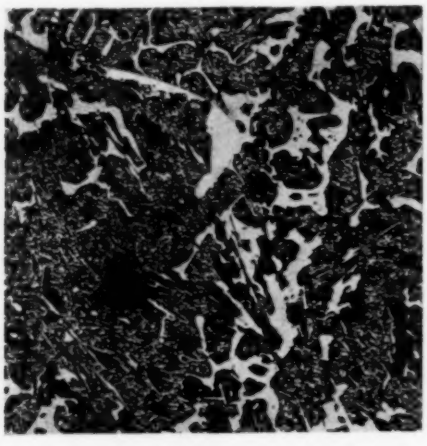


FIG. 31—QUENCHED AFTER 12 HOURS AT 800 DEGREES CENT.—X 100 DIA.

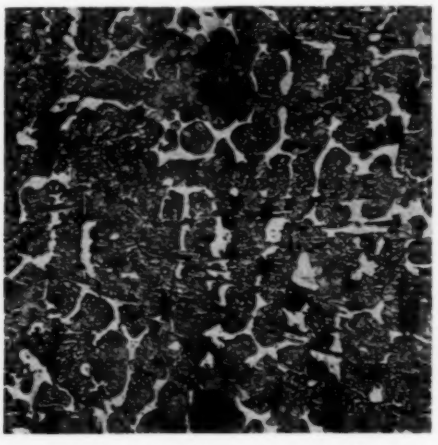


FIG. 32—QUENCHED AFTER 15 HOURS AT 800 DEGREES CENT.—X 100 DIA.

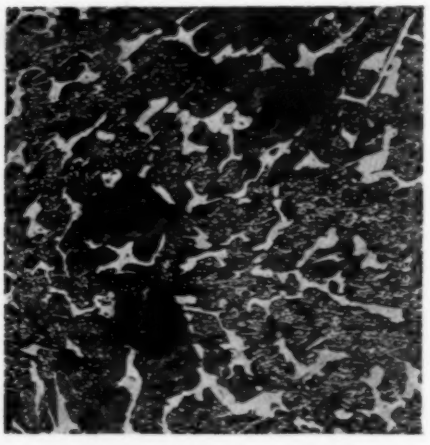


FIG. 33—QUENCHED AFTER 18 HOURS AT 800 DEGREES CENT.—X 100 DIA.

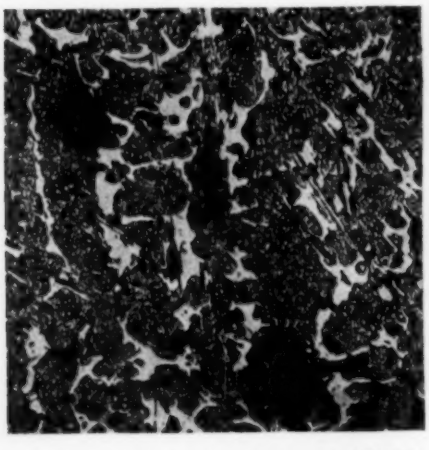


FIG. 34—QUENCHED AFTER 25 HOURS AT 800 DEGREES CENT.—X 100 DIA.

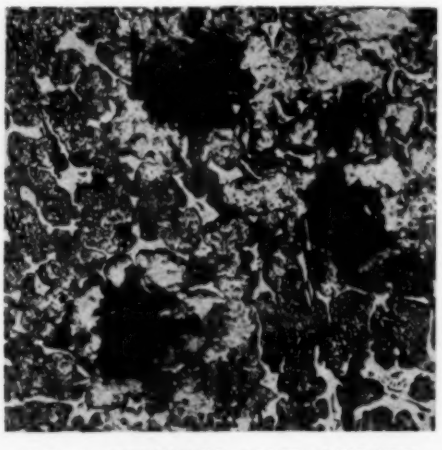


FIG. 35—QUENCHED AFTER 48 HOURS AT 800 DEGREES CENT.—X 100 DIA.

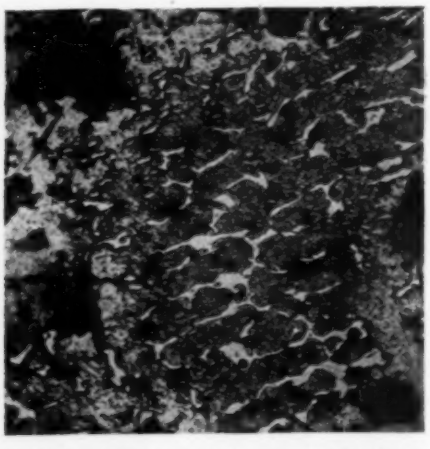


FIG. 36—QUENCHED AFTER 60 HOURS AT 800 DEGREES CENT.—X 100 DIA.

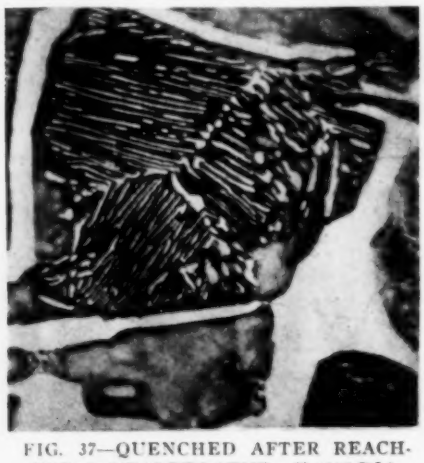


FIG. 37—QUENCHED AFTER REACHING 800 DEGREES CENT.—X 1000 DIA.

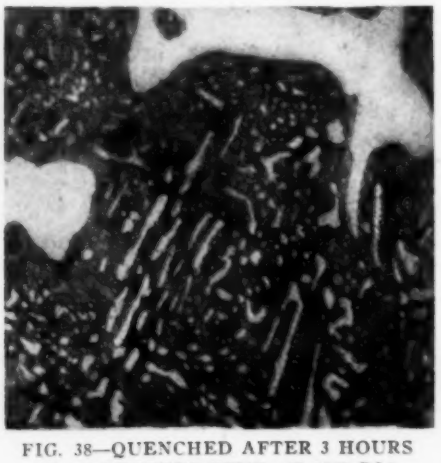


FIG. 38—QUENCHED AFTER 3 HOURS AT 800 DEGREES CENT.—X 1000 DIA.

FIG. 39—QUENCHED AFTER 8 HOURS AT 800 DEGREES CENT.—X 1000 DIA.

with nichrome wire surrounded by pea-size firebrick held in an asbestos-board container. The tube ends and furnace openings were sealed as effectively as possible and the bars annealed for 55 hours at the highest temperature attainable—between 1080 and 1100 degrees Cent. At the end of this time, the bars were cooled in the furnace at a rate approximating 10 degrees Cent. per hour until 800 degrees had been reached. The specimens were then cooled at the rate of about five degrees per hour until well below the critical range. A recording pyrometer furnished a complete record of temperature variation. The thermocouple and recorder were carefully standardized by making freezing-point determinations on pure metals before and after each anneal described.

Effect of Too Rapid Cooling

After being broken in tension, the bars showed a partial white fracture. It later developed that this was due to too rapid cooling through the critical range. The tension test values were, of course, affected by the pearlite causing this partial white fracture, and for this reason, the tests were repeated, as described under anneal IV.

Anneals IV to IX—All of the anneals of this series were conducted under the conditions described in detail under anneal III. A summary of the annealing data is to be found in table III.

All of the bars annealed in the laboratory were machined to 0.505 inch diameter before breaking. The purpose of this machining was twofold: (1) To eliminate any effects of the decarburized layer which would vary in depth with the temperature of anneal; that is, to obtain tensile data representative of the "heart" or real body of the casting. (2) To facilitate the measurement of percentage reduction in area. The machining of the bars may be open to criticism, since it is contrary to practice, but this seemed to be the most feasible way of eliminating an objectionable variable, namely, decarburization. A set of bars annealed at the temperature ordinarily obtained in commercial work (788 degrees Cent.) and then machined before breaking, furnished a reference point for the tensile properties of machined bars.

Table IV
Tensile Properties of Bars Annealed in Laboratory

Bar	Number	Diameter, Inch	Yield point, Pounds per square inch a	Ultimate strength, Pounds per square inch	Elongation in 2 inch, Per cent	Reduction in area, Per cent
III	1	0.505	41,350	57,550	15.0	11.6
III	2	0.503	36,390	56,170	17.0	12.7
IV	1	0.507	32,630	45,450	15.5	13.3
IV	2	0.504	32,760	45,880	14.5	11.0
V	1	0.503	36,880	48,240	9.0	10.5
V	2	0.505	35,500	50,250	12.5	10.0
VI	1	0.505	32,400	48,700	14.0	13.0
VI	2	0.505	33,000	46,800	10.0	11.0
VI	3	0.506	36,800	47,800	9.5	10.2
VII	1	0.505	39,600	53,250	5.5	3.5
VII	2	0.505	40,600	56,250	6.0	3.0
VIII	1	0.504	40,000	56,880	5.0	1.5
VIII	2	0.502	43,700	61,310	4.0	2.5
IX	1	0.506	51,140	63,420	2.0	1.5
IX	2	0.505	....	62,800	2.0	1.0

a As obtained by the beam-drop method.

The tensile test results obtained on these bars are recorded in Table 4. Table indicates that normal black fractures were obtained after two anneals only, namely, at 1100 degrees and 830 degrees Cent. From the standpoint of tensile strength, the lower temperature anneal yields values slightly greater than the higher anneal. From the standpoint of ductility, however, the higher temperature anneal gives somewhat higher values. The higher tensile-strength and yield-point values and the lower ductility values of the other anneals must be attributed to the presence of combined carbon, and not to any specific properties of the ferrite matrix or temper carbon areas.

As stated before, the annealing of white iron seems to permit of considerable latitude with respect to temperature without causing serious deterioration as measured by the tensile test. We believe, with Rawdon,[a] however, that the tensile test does not sharply or adequately differentiate between two metals of the same chemical composition that differ only in the degree of fineness of the structural elements. It is quite probable that shock or impact tests on this material would have indicated more faithfully the significance of variation in the grain size of the ferrite matrix and the temper carbon areas.

[a] H. S. Rawdon: Effect of Metallic Structure Upon Properties. Chem. & Met. Eng. (March 23, 1921) 24, 523.

Microstructures of Annealed Bars

Anneal III, (1100 degrees Cent.) Fig. 9 is the microstructure of the portion of the bar showing black fracture. Fig. 10 is representative of the portion showing white fracture. It is evident that the partial white fractures were caused by too rapid cooling through the critical range, since the so-called *bull's eye* structure of Fig. 10 is always associated with rapid cooling at that stage.

Anneal IV, (1100 degrees Cent.) Figs. 11 and 12 are representative of the microstructure of each bar. No combined carbon was noted in either specimen. The coarse irregular temper-carbon particles and the coarse-grained ferrite of the matrix, also the suggestion of radial growth of the ferrite about the temper-carbon spots, bear out the results of anneal III. The coarseness of these structures is brought out more forcibly by a comparison with the structure of Fig. 5. It is obvious that a high annealing temperature (1100 degrees Cent. or over) results in a coarse irregular type of temper carbon, and a coarse-grained ferrite matrix.

Anneal V, (785 degrees Cent.) Fig 13 is representative of the microstructure of these bars and shows that a certain amount of combined carbon was present after annealing. However, the structure produced is much finer than that shown in Figs. 9, 11, and 12, and, except for the cementite, is more like that shown in Fig. 5.

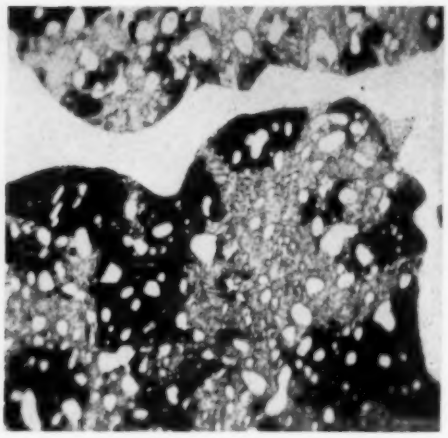
Anneal VI, (830 degrees Cent.) Fig. 14 is thoroughly representative of the microstructure of white iron annealed at 830 degrees Cent. It is to be noted that, although the temper-carbon spots are rather coarse, the ferrite grain is much finer than in the bars annealed at the higher temperatures.

Anneal VII, (770 degrees Cent.) Fig. 15 shows the presence of cementite. Fig. 16, the same specimen etched with sodium picrate, reveals the cementite

Table III
Summary of Annealing Data

Anneal number	Temperature of anneal, Degrees Cent.	Period of anneal, Hours	Rate of cooling, degrees Cent., per hour	Fracture a	Remarks
III	1100	55	10 to 800 5 to 650	Approximate, 40 per cent white	White fracture due to too rapid cooling
IV	1100	60	10 to 770 4 to 650	Normal black	
V	785	63	4 to 650	Approximate, 10 per cent white	
VI	830	70	3 to 700	Normal black	
VII	770	93	2¾ to 650	White	Temperature never below Ac_1
VIII	770	121	4 to 650	White	
IX	750	98	4 to 650	White	

a With the exception of anneal III, all of the white fractures recorded were due to insufficient time at the temperature specified and not to too rapid cooling.



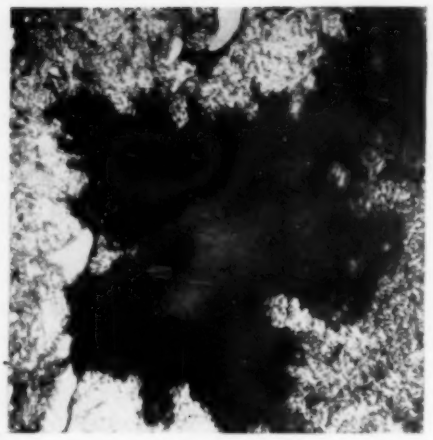


FIG. 40—QUENCHED AFTER 12 HOURS AT 800 DEGREES CENT.—X 1000 DIA. FIG. 41—QUENCHED AFTER 15 HOURS AT 800 DEGREES CENT.—X 1000 DIA. FIG. 42—QUENCHED AFTER 18 HOURS AT 800 DEGREES CENT.—TEMPER CARBON SPOT IN SOLID SOLUTION AREA—X 600 DIA.

more clearly. The ferrite is not much finer in grain than that shown in Fig. 13 but the temper-carbon particles are somewhat larger, more regular in outline, and more compact. The cementite in Figs. 13, 15, and 16 is of the massive variety caused by insufficient temperature during anneal, rather than of the pearlitic or sorbitic variety caused by too rapid cooling, as in Fig. 10. An examination of structures and tensile data of anneals III, V, and VII leads to the conclusion that pearlitic or sorbitic cementite from rapid cooling, even though there is more of it, is much less harmful from the standpoint of ductility than the massive cementite resulting from under annealing.

Anneal VIII, (770 degrees Cent.) This heat treatment was the second attempt to get complete graphitization at this temperature (just above Ac_1) by using a longer annealing period. Figs 17 and 18 show that the attempt was unsuccessful, as there was almost as much massive cementite in these specimens as in Figs. 15 and 16. Attention is called to the fine-grained ferrite and the rather large, regularly outlined temper-carbon particles of Fig. 17.

Anneal IX, (750 degrees Cent.) These bars, annealed at a temperature just below the Ac_1 of white cast iron, were entirely white in fracture. Figs. 19 and 20 show the large amount of massive cementite remaining in the bars after annealing. Attention is called to the fine-grained ferrite and the compact, regularly outlined temper-carbon particles. It might take from two to three weeks to completely graphitize at this temperature.

The study of the microstructure of the bars described lead to the following conclusions:

1—The ferrite grain size increases with the temperature and, probably, with time of anneal.

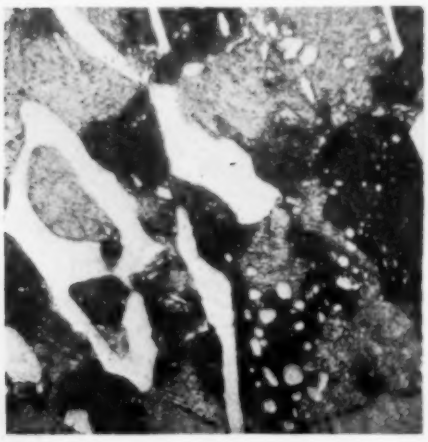
2—The temper-carbon areas produced at the lower temperatures are more compact and sharply outlined than the graphitic areas obtained at the higher temperatures. High-temperature temper carbon is, in general, characterized by a more or less porous structure of ragged and *spidery* outline. The higher temperatures have a disintegrating effect on the compact and rounded masses characteristic of carbon precipitated at the lower temperatures.

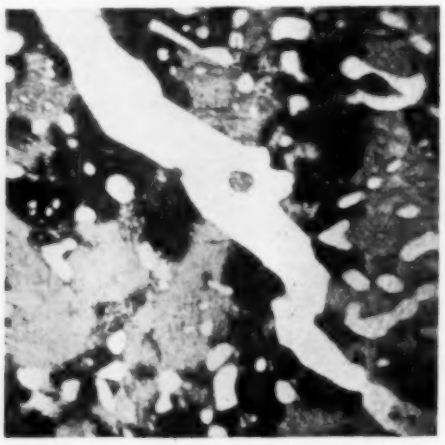
The relation between the thickness of the casting section of white cast iron and the microstructure and mechanical properties of the malleable iron obtained from the hard iron, should be of considerable interest to those engaged in the production of malleable castings. Presenting the problem a little differently, the manufacturer is interested in the effect of the rate of cooling of the hard casting on the mechanical properties of the malleable casting subsequently obtained, assuming constant chemical composition.

In a recent paper,[1] micrographs of three specimens of different thickness annealed at a common temperature seemed to indicate that the size of the ferrite and temper-carbon areas increased with the wall thickness. As far as we are aware, no direct comparison between the structural characteristics of malleable iron and the original white iron castings of varying thickness have been published.

To add to our knowledge on this subject, we secured a white iron casting, in the form of a wedge, of the same composition as was used in the other

[1] Bean, Highriter and Davenport: Fractures and Microstructures of American Malleable Cast Iron. Trans. Amer. Foundrymen's association (1920) 29.





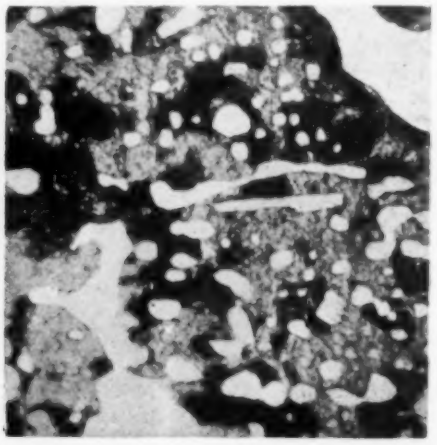


FIG. 43—QUENCHED AFTER 25 HOURS AT 800 DEGREES CENT.—X 1000 DIA. FIG. 44—QUENCHED AFTER 48 HOURS AT 800 DEGREES CENT.—X 1000 DIA. FIG. 45—QUENCHED AFTER 60 HOURS AT 800 DEGREES CENT.—X 1000 DIA.

experiments. Figs. 21, 23, and 25 show the structure of three cross sections corresponding to the following dimensions. The section shown in Fig. 21 was 1 by 0.05 inch; that shown in Fig. 23 was 1 by 0.25 inch; and that shown in Fig. 25 was 1 by 0.45 inch.

As might be expected, the rapid cooling in the lightest section (Fig. 12) has produced a finely divided mixture of pearlite and cementite and the structural elements become coarser as the wall thickness increases, *i.e.*, as the rate of cooling decreases.

The three specimens were then packed in sand and annealed with the bars of anneal VI (Table 3), the resulting structures are shown in Figs. 22, 24 and 26.

A comparison of the hard iron structures and the corresponding malleable structures indicates that: (1) the finer the hard iron structures the finer will be the ferrite grain and temper-carbon areas of the malleable iron; (2) the effect of the wall thickness, and therefore the rate of cooling of the white cast iron, is more pronounced in the case of the temper-carbon areas than in the case of the ferrite.

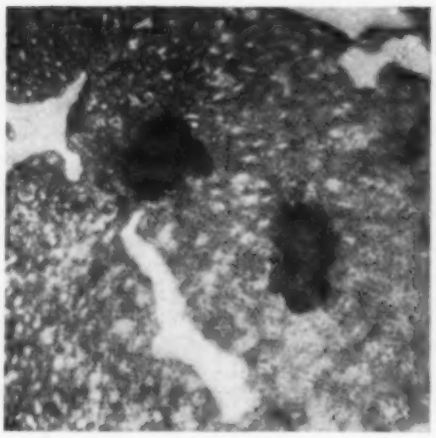
Heavy Wall Sections Affects Properties

Although no tensile data were obtained in this experiment, direct comparison of the structures described with those corresponding to known tensile properties leads to the conclusion that variations in wall section cause more pronounced variations in mechanical properties than can be attributed to the thermal gradient incidental to ordinary mill anneal. Doubtless poor mechanical properties are often obtained due to the additive effect of a very high annealing temperature and a heavy wall section.

Briefly stated the completely cooled normal white iron consists of pearlite and cementite. There are, however, four kinds (from the viewpoint of origin and of aggregation) of cementite, namely; massive pro-eutectic cementite, eutectic cementite, pro-eutectoid cementite, eutectoid cementite (pearlite).

In some instances, it is possible to distinguish all of these elements within a rather limited area. However, more often we are unable to make these deductions with any degree of assurance. The massive pro-eutecttic cementite results from supercooling as indicated by the prolongation of line *A B*, Fig. 27.

Fig. 1 is typical of the structure of rapidly cooled cast iron. The ledeburite (eutectic) in the lower left-hand corner is small in amount because of the large amounts of structurally free cementite resulting from supercooling. The pro-eutectoid cementite is in the form of needlelike areas. The dark areas consist of pearlite formed by the transformation of the austentite at the A_1 point.



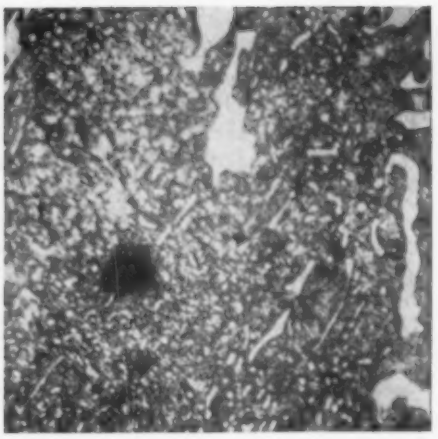


FIG. 46—QUENCHED AFTER 21 HOURS AT 780 DEGREES CENT.—X 500 DIA. FIG. 47—QUENCHED AFTER 21 HOURS AT 780 DEGREES CENT.—X 500 DIA.—MICROGRAPHS SHOW TEMPER CARBON SPOTS IN SOLID SOLUTION AREAS

Much has been written on the general subject of the graphitization of gray and malleable iron. The earlier investigators in this field apparently believed that it is essentially the structurally free and metastable cementite that decomposes at the higher temperatures to form ferrite and graphite, or temper carbon. However, several investigators, notably Storey,[8] Archer,[9] and Mercia[10] have suggested the possibility of graphitization direct from solid solution. The writers have been of this opinion for some time and submit micrographs that, although not necessarily conclusive on this point, tend to indicate that under ordinary treatment of white cast iron temper carbon is formed directly from the solid-solution areas and not, in general, from the massive cementite areas.

Specimens of white cast iron of normal composition were packed in sand in small fireclay container. The containers were then placed in an electric-resistance muffle furnace and heated to 800 degrees Cent. At predetermined intervals, arbitrarily chosen, one specimen was drawn from the furnace and quenched by throwing the container into a large body of cold water. The containers were opened as soon as they struck the water and the specimens subjected to the quenching action. The marking and treatment of the specimens were as follows:

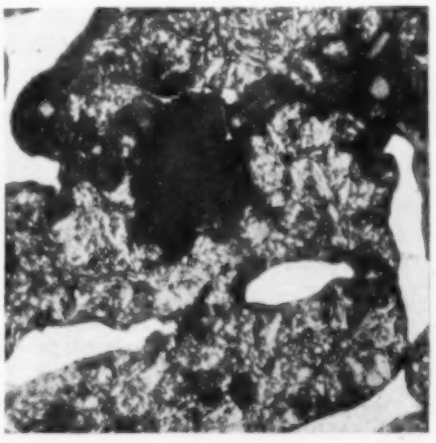
Specimen No.	Treatment
G0	Quenched after reaching 800 degrees Cent.
G1	Quenched after 3 hours at 800 degrees Cent.
G2	Quenched after 8 hours at 800 degrees Cent.
G3	Quenched after 12 hours at 800 degrees Cent.
G4	Quenched after 15 hours at 800 degrees Cent.
G5	Quenched after 18 hours at 800 degrees Cent.
G6	Quenched after 25 hours at 800 degrees Cent.
G7	Quenched after 48 hours at 800 degrees Cent.
G8	Quenched after 60 hours at 800 degrees Cent.

Figs. 28 to 36 show the microstructures representative of each specimen in the series at 100 diameters Figs. 37 to 45 show the same specimens at higher magnifications. It is evident that during the earlier stages of anneal, the only visible changes taking place are the coarsening the pearlite lamellæ and perhaps a slight spheroidizing of the proeutectoid cementite, as shown by

[8] O. W. Storey: Researches in Annealing Process for Malleable Castings. Trans. Amer. Foundrymen's assn. (1914) 23, 460.

[9] Loc. cit.

[10] Merica and Gurevich: Graphitization of White Cast Iron upon Annealing. Trans. (1920) 62, 509.



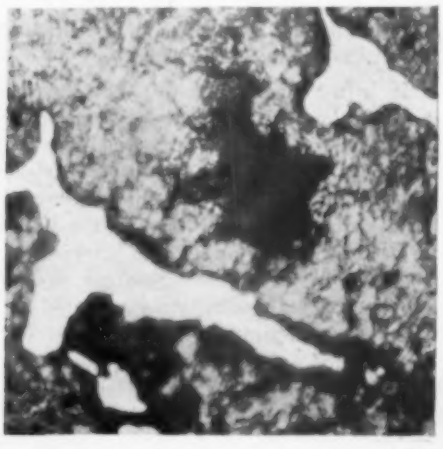


FIG. 48—QUENCHED AFTER 20 HOURS AT 800 DEGREES CENT.—X 500 DIA. FIG. 49—QUENCHED AFTER 20 HOURS AT 800 DEGREES CENT.—X 500 DIA.—MICROGRAPHS SHOW TEMPER CARBON SPOTS IN SOLID SOLUTION AREAS

Figs 28, 29, 37, and 38. Temper carbon was first positively identified in the specimen quenched after 12 hours annealing (Fig. 31). The presence of temper carbon in the specimen quenched after 8 hours annealing is extremely doubtful (Fig. 30).

In these, and other observations made by us, the temper carbon in quenched specimens seems to be coincident with the appearance of troostite or martensite. This would seem to signify that no appreciable amount of temper carbon is precipitated until a saturated solution is formed. Figs. 39, 40, 41, 43, and 45, representative of quenched specimens highly magnified, show the structure to consist essentially of massive and spheroidized cementite in a matrix of martensite or troostite or a mixture of the two. The dark areas in the matrix (Figs. 41, 43, 44, 45) are troostitic and are not to be mistaken for temper carbon. A typical temper carbon spot at high magnification is shown in Fig. 42. This is apparently embedded in a matrix of fine-grained martensite.

As the time of anneal increases, the size and number of temper-carbon areas increase, as might be expected. Although it is impossible to make any positive statement regarding the structural element giving birth to temper carbon during the early stages of graphitization, we believe from certain quenched samples, *e.g.*, Figs 31 to 34, that the temper carbon was first precipitated in appreciable amounts in the solid-solution areas and not, in general, in the patches of massive cementite. As additional evidence four micrographs of two specimens, one quenched after 21 hours at 780 degrees Cent. (Figs. 46 and 47), and the other quenched after 20 hours at 800 degrees Cent. (Figs. 48 and 49). In the specimens quenched after 25 hours, the temper carbon areas are bulky; consequently, little can be said regarding the structural conditions prior to graphitization. However, it is possible that during the later stages of separation some of the massive cementite also undergoes decomposition.

It is not unlikely that slight fluctuations in temperature during the effective annealing period may play an important part in the formation of temper carbon. After the austenite has become saturated with carbon, whether it is in the form of cementite or as atomic carbon,[11] a slight drop in the temperature would render the austenite supersaturated at the lower temperature and carbon would be rejected, apparently as temper carbon. As temper carbon is less soluble than cementite in gamma iron, when the temperature rises the austenite would become saturated at the expense of the structurally free cementite. Thus alternate precipitation and saturation take place throughout the anneal; moreover, further separation of temper carbon takes place during the slow cooling following the anneal since the solubility of carbon in austenite decreases with falling temperature. In properly annealed malleable castings little combined carbon can be found, either analytically or micrographically, and we are inclined to believe that the iron-graphite eutectoid is at approximately zero per cent carbon.

[11] As a result of recent investigations by means of the X-ray spectrometer, Jeffries states that "the carbon in austenite is present as individual atoms." Chem. & Met. Eng. (June 15, 1921) 24, 1057.

Organize New Equipment Company in New York

The Mutual Equipment Co., 251 Fort Washington Ave., New York, recently has been organized by D. E. Hadley, S. H. Baird and J. F. Kevern, all of whom formerly were connected with the W. W. Sly Mfg. Co., Cleveland, in sales or engineering capacies. The new organization purposes to develop sand-blast equipment, dust arresters, core ovens, tumbling mills and other special machinery for foundry service.

Rules for Finding Ladle Holding Capacity

Question: I should like to see an example worked showing the method employing for figuring the volume of capacity of a cylindrical shaped ladle of uniform diameter, say 25½ inches and 21 inches high. Also should like to have the formulas or rules for determining the amount of iron held in the crucible zone of a cupola.

Answer: Two methods are available The first is the well known arithmetical rule of squaring the diameter, in inches, multiplying the result by the constant 0.7854 to get the area, multiplying this result by the height 21 also in inches, to find the cubical contents or volume and finally multiplying by 0.26, the weight of a cubic inch of cast iron. Thus:

(1)	25.5	(2)	650.25
	25.5		.7854
	1275		260100
	1275		325125
	510		520200
	650.25		455175
			510.706350
(3)	510.70	(4)	10724.70
	21		26
	51070		6434820
	102140		2144940
	10724.70		2788.4220

The second method has been designed especially for foundry use. By the use of the constant 0.206 the second and fourth step in the foregoing method have been combined thus shortening the process to a considerable extent, thus:

(1)	25.5	(2)	650.25
	25.5		.206
	1275		390150
	1275		130050
	510		133.95150
	650.25		
		(3)	133.95
			21
			13395
			26790
			2812.95 pounds

The result by both methods is the same approximately 2,800 pounds, which is near enough for all practical purposes.

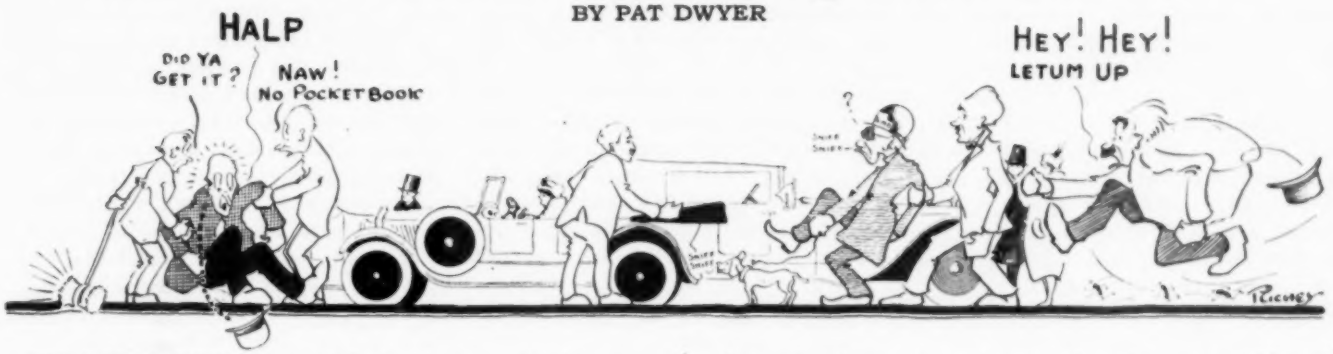
Ladles usually are made with more or less taper to the sides. The only difference this feature makes in the calculation is that it will be necessary to select the proper diameter. It is apparent that if the bottom diameter is used the total will be under, and if the top diameter is employed the total will be over, the correct amount. On tapered ladles, and of course on all similar tapered shapes, the rule is to add the figures, representing the top and bottom diameters and divide the result by 2; which will give what is known as the mean diameter. For instance if the ladle is 27 inches at the top and 23 inches at the bottom, the mean diameter, the diameter to be used when figuring the contents, or volume will be 27+23÷2= 25 inches. The same rule is used to find the quantity of iron that can be collected in the well of the cupola. By dividing the last answer by 2 to allow for the coke in the bed the amount will be approximately correct. For instance to find the holding capacity of a cupola lined to 40 inches; square the diameter, multiply by 0.206, multiply by the height from the sand bed to the bottom of the sag hole, if there is one, if not, to the bottom of the tuyeres and divide the final result by 2, thus:

(1)	40	(3)	329.600
	40		10*
	1600		3296.00
(2)	.206		
	9600	(4)	3296.00
	3200		1648.00**
	329.600		

*Height to tuyeres.
**Pounds of iron in wells.

Bill On Pattern Mounting Methods—III

BY PAT DWYER



CURIOSITY is an attribute of human nature that manifests itself in various ways in different people. So far as I have been able to determine, it does not depend on race, color, creed, or former state of servitude and is observed just as frequently in a virulent form in the meek and lowly as it is among the opulent and haughty and the great ones of the earth. This sage reflection was borne in upon me the other night when Bill called at the house and invited me to accompany him to the automobile show. I have no intention of buying a new car this year and therefore had not been sufficiently interested to think of going on my own account and when I asked Bill if he had a mind to trade in his old machine for a new one he said certainly not. He just wanted to go and look 'em over. The reason did not appeal to me, probably on account of an under-developed bump of curiosity along that particular line, but I reflected that an evening spent in Bill's company would not be time ill spent and perhaps I might pick up a point or two that would assist me.

We found the place crowded, particularly around the higher priced machines. Some of the cars were occupied by one person, some by two and, in a few instances the entire family of three, including the dog, leaned luxuriously back against the genuine Spanish leather while the impressive looking young salesman leaned in over the door and recited his little lesson. We ranged from one end of the building to the other as rapidly as possible the first time, with the intention of returning more leisurely, with stops at several points that attracted our attention on the first part of the journey. We stopped in front of one chassis in which the engine was turning over slowly and where the cylinder block and several pistons had been cut open to illustrate the manner in which the engine functioned. Bill has been accustomed to heavy machinery all his foundry life and, therefore, he was impressed particularly by the high finish on the castings and the beautiful even thickness of metal shown at the cut sections.

A snappy, young go-getter lad with all the facial characteristics and mannerisms set forth as essentials in the Salesman's Manual approached and inquired if we were interested. If I had been alone I should have told him that I was not a prospective customer and thus have prevented him from wasting any of his time on me. Bill had other views. He confided to me afterward that the cocky, confident, superior air assumed by these brilliant young captains of industry always gave him a pain. They seemed to act on the assumption that the customer knew nothing and that their job was to sell him the goods irrespective of whether he wanted it or not.

Bill told the young man he was thinking of buying a car, a plain moderate priced machine, one that had no fancy hickeys and doo-dads to get out of order, one which he could learn to drive himself and one that would stand a reasonable amount of hard usage. Also, he wanted one that did not have to stop at every gasoline station to have the tank refilled. As Bill enumerated the list of selling points, the young man's eyes glistened with anticipation over what he considered a gift of Providence, a customer made to order. He scarcely could restrain his impatience until Bill had finished, to launch into a eulogy of the machine he handled, which, as he was at pains to point out, not only included all the points Bill had raised, but many others of a supplementary character, which without a shadow of a doubt, gentlemen, placed the car in a class by itself. He was willing to concede that some of these features might be found in other cars, but certainly no other one car possessed them all. Bill listened with the most gratifying attention while the young man praised the ignition system, the leather upholstery, the body design, the springs, the special alloy steel parts, the cooling and lubricating systems, the sturdy pressed steel frame and the superior quality of steel used in the hood. The latter was a feature of which his company was rather proud and he defied the world to show a car in which the steel in the hood was superior to the one on which he now held his hand. When the needle began to grate a little, showing that he had about finished his little record, Bill wound him up again and started him off on a new one. He leaned over confidentially and told the young man he never had driven a car; up until recently he had not been in a position to buy one and, he never had any mechanical experience. The net result of this combination of circum-

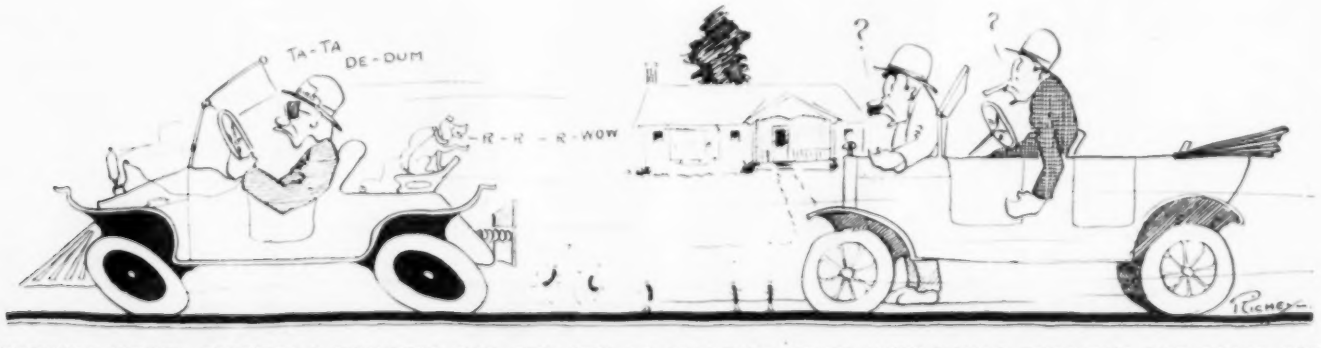
THE SALESMAN PUT THEM NEXT TO SOME INSIDE DOPE ON CYLINDER CASTINGS

stances was that he had no idea of how the engine functioned and if the young man had time to explain some of the details he would feel under a lasting obligation. The young man, it appeared, had all the time in the world and if Mr.—er—I didn't get your name? Oh! yes, Mr. T. T. Bull,—if Mr. Bull kindly would step into their touring car model, they could sit in comfort while he described the motive mechanism. I am willing to concede the young man any credit due for having a fair knowledge of the machine, but if any person asked me some of the questions that Bill asked him I should have hesitated to try and sell him a car. I would not trust him to drive a wheelbarrow around the grounds of one of these homes maintained at the public expense for the feeble-minded. When apparently he had exhausted the subject Bill started off on a new tack by inquiring if the cylinders were made of steel. He assumed from what the young man had told him of the tremendous explosions taking place on the inside that the cylinders must be made of extraordinarily strong material. The salesman assured him that the supposition was perfectly natural, but the cylinders were made of cast iron. Not, of course, ordinary cast iron, which, as Mr. Bull probably was aware, is full of impurities, but a special material, the cream of the blast furnace product. This iron afterward is alloyed with a certain proportion of pure steel and refined in a furnace after which it is poured into the mold through a strainer which effectually removes the last traces of contamination. Replying to a question touching on the kind of material used to form the molds, he said they employed a superior grade of green sand which he understood, but really he could not be positive on that point, came from the Green mountains in Vermont. Mr. Bull, of course, was familiar with the fact that Vermont simply was a contraction of the French *Vert Mont*, green mountain, and probably was bestowed on the region by the early French explorers on account of the sand deposits which resembled the famous sand beds in the vicinity of Paris. He understood that many automobile engine builders in this country and in England employed yellow, red and even black sand to form their cylinder molds, but his company followed the French practice, and you know the French make some of the finest cars imported into this country. They make all their molds in green sand, he said.

HE IS ELECTED A MEMBER OF THE GOAT CLUB

The same extraordinary care and attention to detail which characterizes the manufacture of the casting up to this point continues after it is taken out of the mold. It is cleaned by a sand-blast machine which removes all sand, scale and exterior blemishes. Then it is placed to soak for three months in an acid bath which acts upon the skin in the same manner as cold cream on the human skin and leaves the casting absolutely clean. Then it is taken to the machine shop where it passes through the hands of a number of men, each one of whom is a specialist who has devoted a life time to one operation. He would not go so far as to say that other cars did not have points of excellence, but really gentlemen, when you considered the many outstanding, distinctive features and compared the price f.o.b. at the factory with any other car in the building. Why, he was satisfied to leave it to your own judgment if it was not the greatest bargain of the year. Bill thanked him profusely, especially for the comprehensive and highly illuminating description of the methods employed in making the cylinder castings. He said they differed widely from what his former conception had been but of course that only exemplified the old adage "Live and learn." He accepted with pleasure the young man's card and assured him that he would ask for him personally in the event that he called at the company's sales and display premises with the object of purchasing a car. We prowled around for some time after that and finally started for home. Bill laughed in derision when I suggested that he had not been justified in wasting the young salesman's time.

"Where do you get that stuff?" he said. "You have been hypnotized like nearly every one else by this continued sales talk, sales advertisement, sales propaganda of all kinds. At the rate public opinion is being molded, there won't be a single young man engaged in a producing capacity in twenty years. They all will be salesmen. I am willing to admit that the salesman is a necessary factor in our industrial life, because if the goods were not sold it would be labor wasted to produce them; but on the other hand if no goods were available all the put-em-over sales campaigns in the world would not sell them. Your average salesman takes himself too seriously. As a class salesmen have influenced public opinion to a point that accepts them at their own valuation. I am willing to admit that I am biased to a certain extent in my opinion. I always have been engaged in the manufacturing end of the game



HUNTING MODEL SPECIALLY DESIGNED FOR THE USE OF SPORTING GENTLEMEN WHILE PURSUING THE BLIND PIG

and have bent every energy to turning out a product that would stand up to every demand made upon it. At the annual meeting, the salesman is presented with a loving cup and has a medal pinned on his breast for taking orders in excess of the plant's capacity and I am told that if I cannot meet the proposed production schedule with the existing force and without increasing the operating expense I shall have a tin can tied to me.

"However, that is not the point I had in mind when I started to talk about salesmen. You said I was not justified in wasting the salesman's time. Did it ever occur to you that the salesman has no compunction in wasting other men's time? Real estate men, insurance men, investment men, automobile men, to say nothing of the canvassers, book agents and peddlers all go from house to house trying to sell toilet articles, mouse traps, clothes lines, washing machines, lightning rods and gun, bug and face powder. Up to the present, including my wife's time, I should say that in the aggregate I have lost about six months in this manner and therefore, I should worry about stringing an automobile salesman along for half an hour. No sir! I don't think a little thing like that will detract from the cordiality of St. Peter's greeting which I finally appear before him and ask to be shown the plat of his reserved seats.

"I have had dealings with automobile salesmen several times within the past few years and I was curious to see if this bird differed from the remainder of the flock. He is just the same as the others. He can talk prices fluently and can rhyme off and repeat a set of stock phrases which with little, or no modification, could be applied to any make of car, but in regard to the methods employed in manufacturing and assembling the product he knows as much about it as I do about the fourth dimension. I have heard there is such a thing and that lets me out."

"Salesmen have no monopoly in that respect," I said. "Few men ever learn more than one branch of a business. In fact the last time I was talking to you, you were bewailing the fact that foundrymen were so remiss in this respect. You pointed out that matchplates, follow boards and pattern plates were familiar objects in nearly every foundry and yet in many cases the men who used them did not know how they were made. In a general way they had a hazy idea and if you asked them to explain the process involved they would do so in a fine, large, off hand manner; but if you pressed them for details they would squirm out from under and if they found themselves in a position where it was necessary to design, lay out and make a plate they would find themselves up among the branches of an exceedingly tall tree and the nearest ladder, like Sheridan on a certain historic occasion, 20 miles away."

"Quite true," said Bill. "Quite true. In many instances perhaps it may be more economical for the foundry to buy pattern plates ready made from some reputable manufacturer of that type of equipment; but that is no reason why the foundryman should not know how the work is done and in the event that the patterns are made in his own shop he should be able to give the patternmaker explicit instructions how and why he wants patterns mounted in a certain manner. The main point I wish to emphasize is that if the foundryman is thoroughly familiar with the methods of mounting patterns he will be what our salesmen friends call *sold* on the idea and constantly will be seeking new methods of application. If he is not familiar with the proposition he will be inclined to look upon it with indifference.

"The relative size of an order or the extent to which a given pattern is to be used will govern in selecting the type of pattern equipment. According to reasons already advanced it is preferable to ram the cope and drag of a mold on separate halves of a split pattern mounted on individual boards rather than ram the cope on top of the drag. A temporary, but at the same time accurate, method for mounting existing patterns for short orders may be described as follows:

"The pattern first is rammed up in an ordinary flask in the usual manner. The cope is lifted off and placed on its back with the pattern still in place. A planed board then is laid on the face of each half mold and the pin holes marked to correspond with those in the flask. The boards are clamped and then each half of the mold is rolled over on its face, or joint side down. By digging down through the sand it easily is possible to drive a few brads through the edges of the patterns into the boards after which the half flasks are rolled back and the half patterns attached to the boards are drawn out of the sand. Two or more screws are driven through the board into each pattern and the job is done. An average pattern may be mounted in this manner in 20 minutes and therefore it is not hard to believe the statement that it pays to mount patterns even for ten molds. This interesting method exemplifies in a striking manner that the simple, sure way of proceeding by logical steps is in the end the most efficient. Not a single piece of special equipment is needed to do the job. Not a single measurement is made or required and yet the two halves of the pattern are located with perfect accuracy because the pattern is located on the board by the mold exactly as the board will locate it later in the mold and the board is located by the flask identically as it later will locate the flask. It is impossible to make a mistake."

"Well," said he. "Here we are at your house. I guess it is too late to go in so I shall reserve what I intended to say on other pattern mounting devices until I see you again. You know if a person were minded to go into the subject in detail he could write a fair sized book on the many ramifications into which pattern mounting is divided."

"Why don't you go ahead and write a book?" I said, as I climbed out of the machine. "Judging by some of the material displayed in book shop windows almost any person can do it."

"That's a fair shot for the salesman," said Bill. "Any person can write a book, but it takes a clever man to make the public read it."

Award Tunnel Contract

Booth & Flinn, Ltd., New York, are the low bidders on the construction of the river sections of the proposed New York-New Jersey vehicular tunnel which is to connect the Island of Manhattan with Jersey city. The bid of Booth & Flinn, Ltd., for the entire work, was $19,331,723.50. The only other bidders were Patrick McGovern, Inc. and the Keystone State Construction Co. and the Holbrook, Cabot & Rollins Corp., who submitted a tender jointly. The amount bid by Booth & Flinn, Ltd., was approximately $1,725,000 below the estimate of Clifford M. Holland, chief engineer to the New York and New Jersey commissions. Booth & Flinn previously had built six tubes under the East river.

Under the contract the work on the construction of the tunnel to begin within 60 days of the date of the contract and the tunnel is to be completed within 36 months. For constructing the tunnel, Booth & Flinn, Ltd. will have to purchase 115,000 tons of cast iron tunnel segments, about 12,000 tons of plates, some 2500 tons of shapes, 600 tons of concrete bars, 800 to 900 tons of pipe, a large tonnage of sheets, and considerable other steel.

British Motor Castings Methods-V

Making Patterns for the Front Cover of the Crankcase, the Bottom Half of the Crankcase, the Water-Inlet Casting, Pistons and the Axle Housing

BY BEN SHAW AND JAMES EDGAR

REPRESENTATIVE types of smaller castings for internal combustion engines are described in this and a later article. Many of the smaller castings are simple and do not give either pattern shop or foundry much concern. Therefore, it appears wiser to make a composite article of a few castings, each of which has a distinct peculiarity and which together comprise most of the pitfalls likely to be encountered in making the smaller gasoline engine castings.

It is not suggested that any of the castings shown in the accompanying diagrams are involved or exceptionally difficult. Indeed, to the expert who has specialized in this class of work they are distinctly easy and do not present the constructional problems that a cylinder or crankcase presents.

Patterns for small work such as pistons should invariably be made of hardwood. Baywood is the best wood for all classes of patternmaking, but the question of cost sometimes debars the use of it for larger castings. If pine is used, as with the larger work, it should be free from knots, straight grained and well seasoned. With regard to filleting, dowelling and feather-edges, what was said in the first article applies equally to small work. Wood dowels are not recommended, feather edges are invariably bad, and leather fillets are as satisfactory as fillets cut from the solid if they are well worked in.

Figs. 1 and 2 show the front cover of the crankcase described in a previous article. It may be observed that there is an internal flange. It is of course an aluminum casting. If such a casting was wanted in a hurry—a one-off job—there would be no question of molding it on a machine. The pattern would be glued in two thicknesses, and the corebox prob-

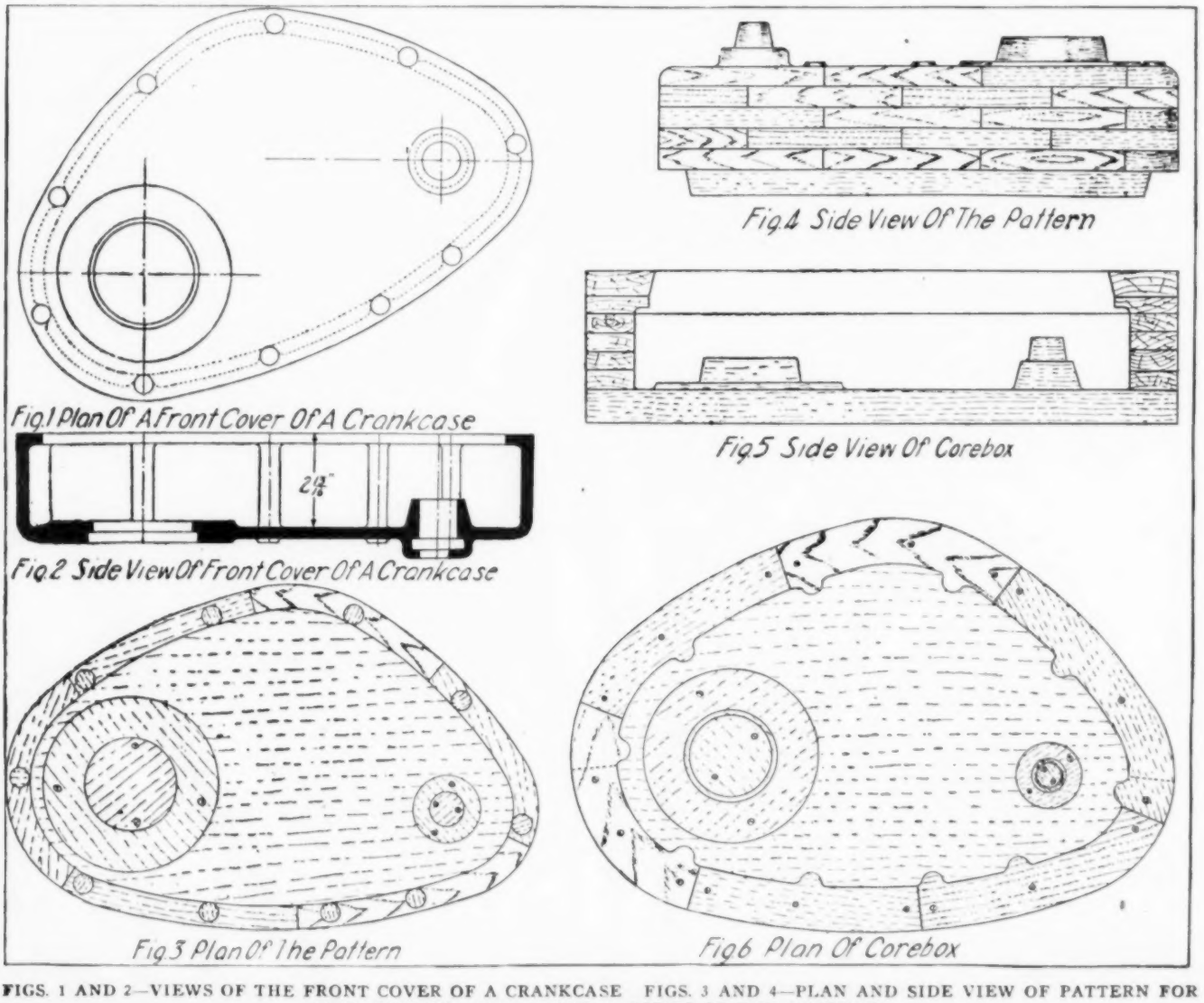
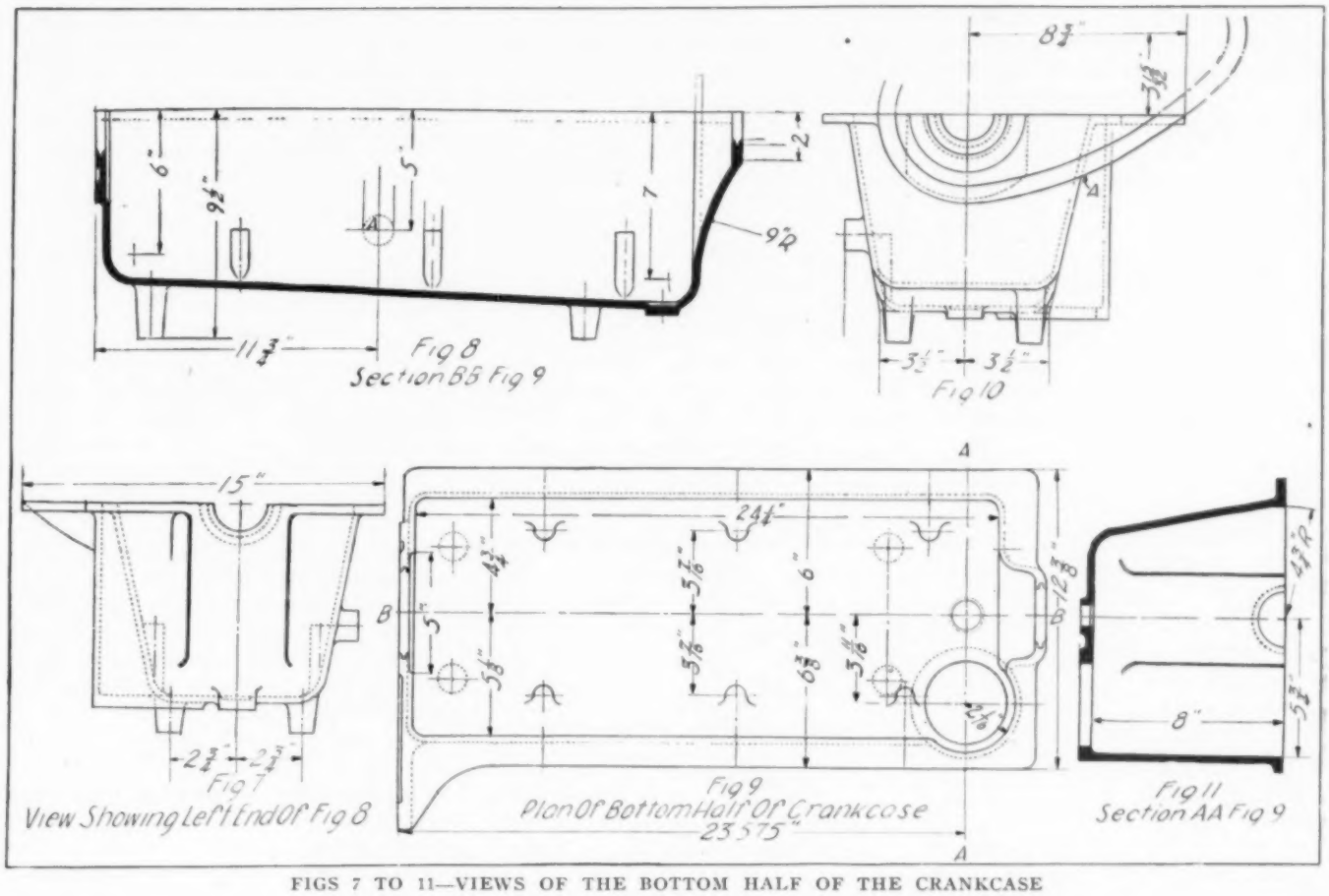


Fig.1 Plan Of A Front Cover Of A Crankcase
2⅞"
Fig.2 Side View Of Front Cover Of A Crankcase
Fig.3 Plan Of The Pattern
Fig.4 Side View Of The Pattern
Fig.5 Side View Of Corebox
Fig.6 Plan Of Corebox

FIGS. 1 AND 2—VIEWS OF THE FRONT COVER OF A CRANKCASE FIGS. 3 AND 4—PLAN AND SIDE VIEW OF PATTERN FOR THIS CASTING FIGS. 5 AND 6—VIEWS OF THE COREBOX



FIGS 7 TO 11—VIEWS OF THE BOTTOM HALF OF THE CRANKCASE

ably would be made of a bottom plate on which one thickness block would be screwed, the shape drawn, and the block taken off and cut to shape. This could be quickly done and, for an experimental job, would be satisfactory. However, something better is wanted for quantity production. Figs. 3 and 4 show a suitable pattern.

The segmental method of construction lends itself to a shallow piece of work such as this. It might be built by other methods such as making a solid block and insetting cross battens to prevent it warping, but it is nearly always a disadvantage to have side and end grain on the same face as every molder knows. The reason segmental work sometimes gets irregular is because of carelessness in jointing or glueing, and frequently because the segments are made too long and the effect is the same as crossing lumber. If segments are of a reasonable length, well jointed and afterward painted and varnished, the surface will remain smooth as long as the pattern holds together. It is not advisable to make the segments thicker than ¾ inch for a small job such as this, and ½ inch is even more satisfactory.

If the work is built longer than the finished size the bandsaw and afterward the sandpapering machine will quickly shape it. There is an unreasonable prejudice in some motor shops against the sander, but it certainly makes as satisfactory a finish as the hand tools. A slight taper should be left. From Fig. 4 it may be seen that the facings on top are turned. It is difficult to avoid feather edges here, but they are not as objectionable when they can be glued down.

In building the pattern no advantage would be gained by the segmental method if the top plate was carried to the outside size, and to obviate this the top course of segments ought to be narrower than those beneath thus forming a shelf on which the top plate can sit. The prints have a special taper; that is, the size across the top of the print may be ⅛ inch less than the correct size of the core, and the corebox is made to suit. If

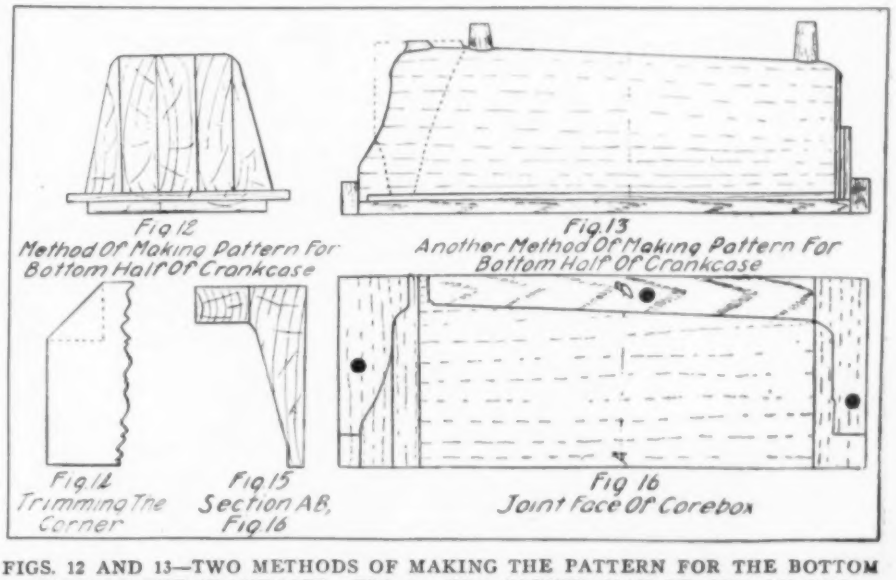
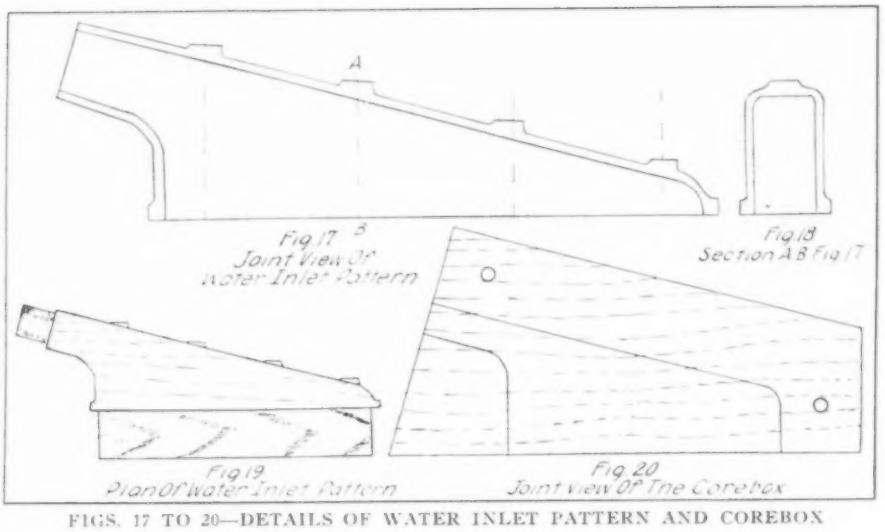


Fig 12
Method Of Making Pattern For Bottom Half Of Crankcase
Fig 13
Another Method Of Making Pattern For Bottom Half Of Crankcase
Fig 14
Trimming The Corner
Fig 15
Section AB, Fig 16
Fig 16
Joint Face Of Corebox

FIGS. 12 AND 13—TWO METHODS OF MAKING THE PATTERN FOR THE BOTTOM HALF OF THE CRANKCASE FIG. 14—THE CORNER MAY BE CUT ON THE DIAGONAL, OR AS MARKED BY THE DOTTED LINES FIG. 15—SECTION *AB*, FIG. 16 FIG. 16—JOINT FACE OF COREBOX

the greatest possible care is not taken to ensure pattern and corebox tapers being identical the tapered print is a



FIGS. 17 TO 20—DETAILS OF WATER INLET PATTERN AND COREBOX

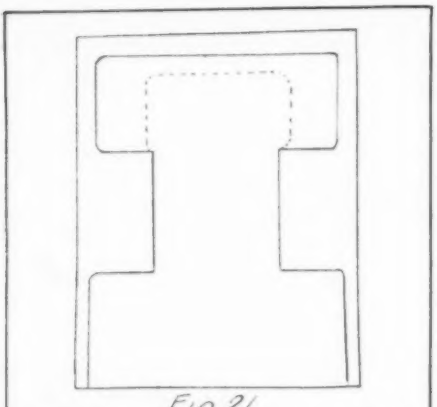


Fig 21
Metal Is Thicker Below The Bosses

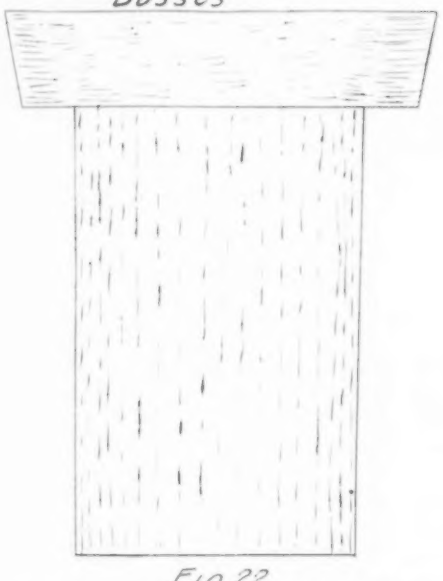


Fig 22
Approved Method Of Making The Piston Pattern

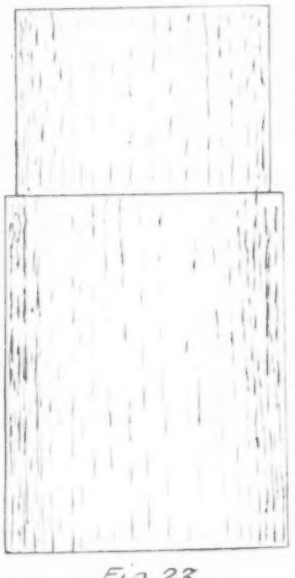


Fig 23
A Second Method Of Making The Piston Pattern

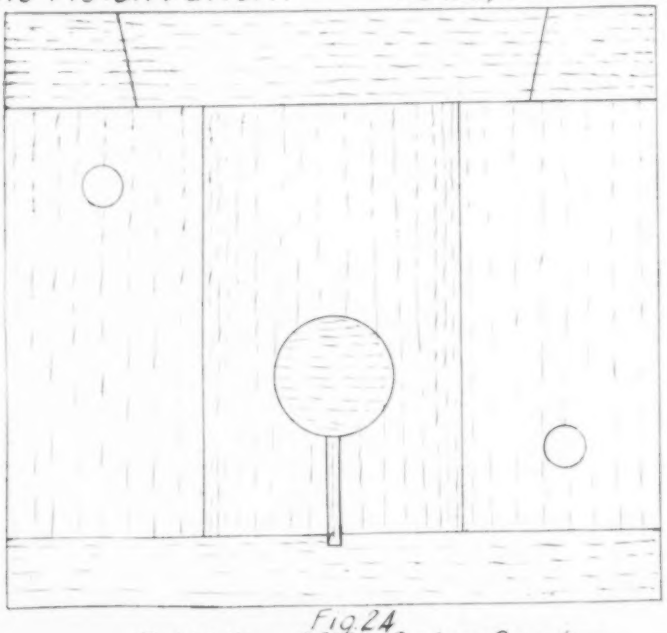


Fig 24
Joint View Of The Piston Corebox

FIGS. 21 TO 24—DETAILS OF PISTON PATTERNS

nuisance to the molder, but it is an advantage and saves any tampering with the mold to get the core set. The main print is shown fastened to the pattern in Fig. 4. It would be taken off in the foundry when fitting the pattern on a plate.

Prints in Corebox

It would be quite possible to make the large facing core a part of the main core but very difficult in the case of the small boss core hence prints are shown in the corebox, Figs. 5 and 6, for both these cores. The segmental construction is as suitable for corebox as for pattern. The print portion of the box because of the special taper and the internal flange must be dowelled and is thus shown made of two laminae of segments, the fillet being carved from the bottom segment. A much more satisfactory result is obtained if the small bosses round the corebox are not made separately because of the fillets. These should be well tapered to avoid trouble when the core is being delivered.

Fig. 6 shows a plan of the corebox with the top plate removed. An altogether different form of construction from the foregoing has to be adopted for such a pattern as the crankcase bottom, Figs. 7 to 11. If it is a fairly large casting, as is the one for the cylinder that was discussed in the first article of the series, it should certainly be boxed up. If this method is adopted fairly thick lumber ought to be used, because of the large radius of the corners. The four sides jointed together to receive the top. The top rests on a check which is sawed from the sides and ends. The sides ought to be screwed into the ends and the screw holes plugged afterward. To give the box additional strength, cover pieces may be glued inside. This is a good method of boxing-up many patterns which are square or rectang-

ular and from which many castings will be wanted.

This pattern will of course be molded with the flange face down in the mold, and the flange should be made in the form of a plate on which the body can rest. Because of the end facing being recessed it is advisable, as may be seen by glancing at Fig. 13, which is a view of the finished pattern, to carry a plate across the end of the box. The facing can be left loose, as there is room for the molder to draw it into the flange. The projecting portion *A*, Fig. 10 can be screwed on, as a separate piece, care being taken to leave the fillet that joins the body with a thick edge which can be trimmed after the glue has set.

The next awkward part of the pattern is perhaps the circular branch at the corner. The simplest way of coping with this on such a boxed-up pattern would be to glue blocks on the box and plane them off flush with the top and then finish the shape. In Fig. 13 this circular branch is shown dotted. It may be observed that end points are shown, in addition to the face print, which need not be thick. Whether end prints are an advantage is a matter of opinion. Before leaving the pattern it may be profitable to discuss another method of construction. This method which is illustrated in Fig. 12 may be used if the pattern is not too large. It consists of jointing 1¼ or 1½-inch lumber with the annular rings back to back. Such a pattern will never alter in shape. This method is occasionally adopted and a certain portion of each piece is sawed away to reduce weight, but when it is necessary to do this it is certainly better and more economical practice to box-up.

Pattern Well Tapered

The various small bosses on the pattern do not call for remark. One good feature about the pattern, from the molder's point of view, is that it is well tapered. The boss *A*, Fig. 8, can be fitted with a long dovetail reaching to the top of the pattern and will then cause no trouble to the molder. The solid construction makes it possible to cut a diagonal at the corner as shown at Fig. 14 for the circular branch. Better than a diagonal is to cut to the dotted line.

There are two ways of making the corebox for this pattern. One is to box it up so that the top of the box will be the print face, and the other to joint, so that the box will be in two halves, the joint face being like Fig. 16. The one method is perhaps equally as good as the other but the second method has advantages from the patternmaker's point of view. Figs. 15 and 16 make the construction fairly clear, Fig. 15 being a section of Fig. 16 on the line *AB*. The two halves are dowelled together and consist of bottom plates on which blocks for the backs and ends are screwed. These are shown in the sketch as single thickness pieces, but for a large box they might have to be jointed of two thicknesses. The bottom fillet might be cut from the solid as shown in Fig. 15, or leather fillets could be employed. The large circular core through the top facing could be made separately and set into a top print.

The water inlet is not as difficult as it is awkward. The body is rectangular and the branch *C* is circular. It is much better to make the change from the body to the branch as a nice sweep, rather than an abrupt shoulder, but the patternmaker must exercise some skill in getting the correct thickness of metal. This is a case where several templets can be used advantageously. The position which these fit should be carefully marked, and the lines transferred to the corebox, when suitable templets again can be used. In other types of water inlets which have separate openings supplying each cylinder jacket, a block print has to be used to balance the core. The pattern and corebox are jointed on the same line, a joint view of each being like Fig. 17. The entire pattern except for the prints conveniently can be shaped from solid lumber. No great molding difficulties arise for the patternmaker to consider, but the large print should be fairly thick, although even this is not absolutely necessary as the core is not very heavy. Fig. 19 is a plan of the pattern and Fig. 20 a joint view of the corebox, which does not require any jointing. Water inlets vary considerably in design and are usually neat examples of patternmaking.

Pistons are more uniform in design than almost any other casting on gasoline engines. As shown, in Fig. 21, the metal is always thicker below the bosses because of the ring grooves. To the writers there appears to be only one good method of making these pistons, and that is the method represented by Fig. 22. The small diameter of the print should be at least 1 inch longer than the diameter of the piston, and the taper may be 3/16 to ¼ inch all around. The print end is of course at the top in the mold, with the core resting on the ledge. The piston should have a fair taper, and, as it is machined, this can easily be arranged. Fig. 23 shows a method that is sometimes adopted, the piston pattern being jointed longitudinally. Not only is it less convenient for core setting, but a clean casting cannot be assured. When the piston is cast open-end up, a head of metal 1 or 2 inches long can be cast on with good results.

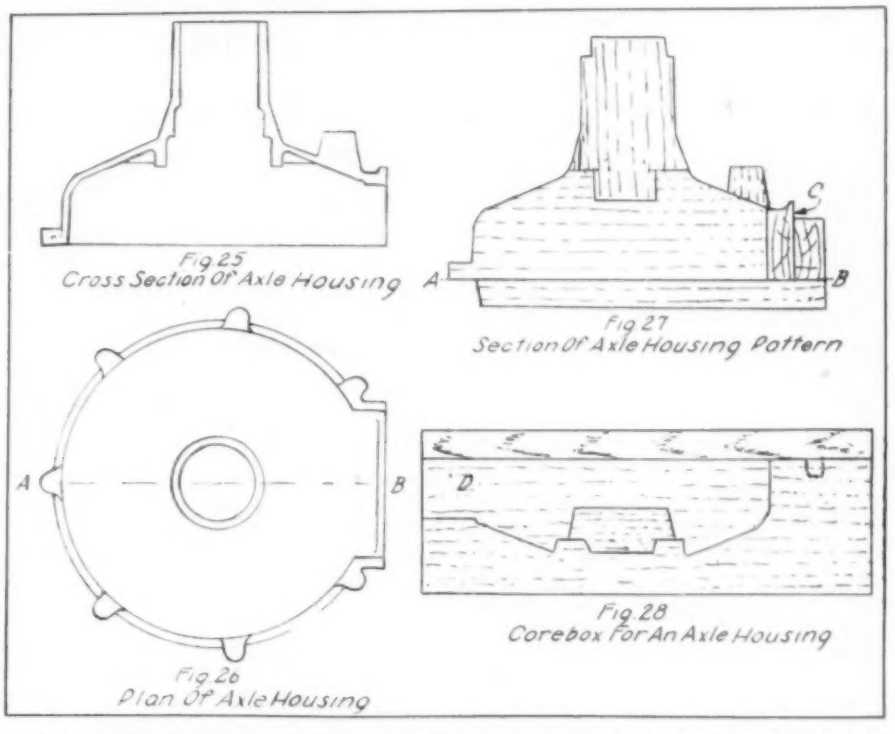


FIG. 25—CROSS SECTION OF AXLE HOUSING FIG. 26—PLAN OF AXLE HOUSING FIG. 27—SECTION OF AXLE HOUSING PATTERN FIG. 28—SECTION OF THE COREBOX

Fig. 24 is a joint view of the piston corebox and scarcely requires any explanation. The bosses are fitted on the bottom of the box to avoid having loose pieces at the joint, and the ribs can be set into the end of the box and also into the bottom. It is not bad practice to set such ribs into the boss as well, and they ought to be generously tapered.

It would not be quite correct to suggest that Figs. 25 and 26 show a universal design of the axle housing because this is a casting that varies considerably, but only in detail. We have seen some of these for heavy vehicles jointed on the line *AB* and with several ribs to what may be termed the branches. The design is modified by the gearing. Some of the larger axle housings constitute quite intricate jobs. When the castings are made in halves, jointed on *AB*, it is usually admissible to make the bosses so they will deliver without having to be loosened. The small extra weight of metal does not as a rule matter. However, in the design we are dealing with, it is not advisable to make a pattern in halves. Fig. 27 is a section of a suitable pattern. As in the case of the piston, a head can be left on the top of the boss. The body of the pattern can be turned, a piece afterward sliced off, and a flange *C* fitted. A small pattern may be turned from one piece of wood, but if large the wood should be jointed in a similar way to the crankcase bottom. The boss can be fitted into the body with a turned dowel. The line *AB* is the actual mold joint line.

With regard to the corebox for the pattern, Fig. 28 is a section of a suitable box. This shows a print on the bottom of the branch core. It may be contended that the complete core should be made in one box. This is quite practicable, but the internal facing must, in this case, be left loose. For this reason it is better to make two separate cores. The box like the pattern may be turned, the part *D* being afterward gouged, through. It is necessary because of the taper on the print to make a loose piece of the top plate.

How and Why in Brass Founding

By Charles Vickers

Cool Metal Causes Shrinks

We are making side rod brasses for locomotives and have had trouble in the case of two patterns for castings weighing 55 and 75 pounds respectively. The composition we are using is 81 per cent copper, 8 per cent tin, 8 per cent lead, and 3 per cent zinc. The patterns are shaped somewhat like the letter U. It is cast with the circle down, and gated at the end. The difficulty is due to shrink cracks which occur at the lowest spot in the circle, and are about 1/8-inch deep. We are making a number of heavier castings with the same metal and have no difficulty whatever. Can you suggest a remedy for the defect?

Difficulties such as described frequently can be overcome by pouring the metal hot enough to form a flash at the joint of the castings, and by raising the heads.

A good way to make rod brasses is to put two in a mold end to end; the gate should be placed between the two castings, and should enter at the top of the bank of sand forming the bearing, right where the crack occurs. Put the patterns apart far enough so a riser 2 inches in diameter will have plenty of room between the castings without danger of *breaking in* at the flanges. Bush this riser up 4 inches above the top of the mold, and have a separate pouring sprue which can be attached either to the gate connecting the two castings about the root of the riser; or the gate can be run into the flanges of both castings. When the sprue is filled, cover it with a bed of sand, and bed a small weight upon it. That will hold in the metal, while the riser head is being filled by dribbling in more metal. Put a fillet on the gate where it connects with the castings; shake out the molds immediately the castings have cooled from a red heat, and clean the castings with a spade after breaking off the gates. One pattern can be worked in a mold, but a greater production results from using two.

By using a heavy gate attached to a feeder, placed high up on the casting, the feeding is done to better advantage and the shrinks will cease. Any locomotive rod brass, molded bearing down, with the entire casting being flowed up into the cope, will crack at the junction of the back and flanges, when poured too cool, or poured with too low a head.

Deoxidizing Copper

We are making copper tuyeres and when using nearly all new metals we have no difficulty, but upon using scrap consisting of old tuyeres we have trouble with the castings leaking. The tuyeres are tested under 80 to 100 pounds pressure. For the jacket core we use lake sand bonded with oil; 1 part oil to 40 parts sand, and for the center core we use half lake sand, half molding sand and bond with oil 1 to 40. We dry the mold and pour from the top. Any suggestions as to the cause of this leakage will be appreciated.

The leakage is probably due to the presence of excessive oxide in the old metal. The castings have been in service and will be more or less oxidized on the surface, and parts may be burned away and oxidized at such points; all of which means dross in the metal. This dross produces unsound metal and the water is able to seep through under slight pressure. All the failures to make sound castings of pure copper can be traced to its condition before it was melted. If the copper is underpoled; that is, contains an undue proportion of cuprous oxide, no ordinary addition of deoxidizer will remove the same and insure sound castings. This case is similar, and it will be necessary to conduct a few experiments. Magnesium has proved to be a good deoxidizer of superoxidized copper. When the scrap copper is melted and bubbling in the pot under its layer of charcoal, add 0.50 per cent of magnesium copper, stir well and add a little common salt and superheat five minutes, then add the usual deoxidizer. The castings so treated may be pressure tight, depending on the amount of the oxide dissolved in the copper. Another way is to mix calcined borax and crushed calcium carbide, a half pound of each, in the bottom of the crucible, and melt the copper, then after it is hot stir up the carbide. Save the skimmings and throw them into a half barrel of water away from buildings, as they will contain acetylene and are a fire hazard. Deoxidize the copper in the usual manner and pour the casting.

Bascule Bridge Trunnions Made in Bronze

We are going to make bronze trunnions for a bascule bridge which must comply with the following physical tests: Elastic limit in compression between 19,000 and 24,000 pounds; permanent set for 100,000 pound load, between 0.12 and 0.16 inches. These bearings must be made of a copper-tin alloy with a maximum content of 1.00 per cent phosphorus. We have made several test pieces but they only show 0.33-inch instead of 0.16-inch. The analysis of the mixture we used follows: Copper, 80 per cent; tin, 9 per cent; lead, 8 per cent; phosphorus from 0.7 to 1.00 per cent. We will appreciate your suggestions.

The formula used will produce a metal too soft for the purpose outlined. It is a well tested bearing metal but unsuited for your purpose and will not meet the specifications. It will be necessary to use the following alloy:

BRIDGE TRUNNIONS

	Pounds	Ounces
Copper	82	10
15 per cent phos. copper	0	6
Tin	17	0

It will be noted that 6 ounces of phosphor copper is used to every hundred pounds of metal. If a crucible is used, place the 6 ounces in the bottom. In a non-crucible furnace the phosphor copper will have to be added after the copper has become liquid and this is not a very satisfactory method. On account of the high tin content it is necesary to watch the phosphorus closely and guard against using too much. The foregoing mixture should show the following properties: Elastic limit under compression 23,500 pounds; permanent set under 100,000 pound load 0.168 inch. This will meet the specifications.

Low Melting Point Alloys

What are the names of different metals or alloys, that have a low melting point, possibly about 500 degrees Fahr. We wish to get an alloy that has the minimum of expansion in changing from the liquid to the solid state.

The melting points of some metals and alloys follow:

Metals	Melting Point, Degrees Fahr.
Tin	449
Lead	620
Cadmium	610
Bismuth	520
Alloy: Tin 25, lead 75 per cent	482
Alloy: Tin 50; lead 50 per cent	372
Alloy: Tin 60; lead 40 per cent	338
Alloy: Tin 75; lead 25 per cent	354
Lipowitz alloy: Cadmium 10; lead 26.6; tin 13.3; bismuth 50.10 per cent	158
Fusible alloy: Cadmium 25.0; lead 25.0; tin 50.0 per cent	187
Wood's alloy; Cadmium 15.4; lead 30.8; tin 15.4; bismuth 38.4 per cent	160
Alloy: Lead 32; tin 16.0; bismuth 52.0 per cent	205
Alloy: Lead 85.0; antimony 15.0 per cent	446
Alloy: Tin 90.0; antimony 10.0 per cent	500

An alloy with very small contraction consists of 50.0 per cent tin and 50.0 per cent zinc.

Coloring Yellow Brass

We would like some information regarding a yellow brass dip for coloring yellow brass, to give it a red brass appearance. This dip is used on small, light castings, but our dip containing nitric and sulphuric acids does not color the yellow brass. We have a casting from our competitor with a red brass appearance, but when dipped in our acids, the red color disappeared, and it became yellow.

One solution used to cause yellow brass casting to look like red brass is made by dissolving 4 ounces of sulphate of copper in 1 gallon of warm water, then adding 2 ounces of sulphuric acid.

The bath is used at a temperature of 115 degrees Fahr., and the castings must be well cleaned previous to immersion. It is necessary to use an iron-wire basket for dipping the castings, as the iron reduces the copper from the solution.

Preventing Iron Inserts from Blowing

We have been making brass handle castings with iron inserts and have had considerable trouble on account of blowing on iron inserts.

The iron inserts will not blow provided they are heated before they are laid in the molds. In the case of small work, the molds must be left open until ready to pour, then they must be cored with the inserts. While these must be hot, they should not be red hot. This high temperature would cause oxidization on the surface of the insert with the result that the brass would be likely to blow due to a reaction between it and the iron oxide.

The iron inserts will blow if they are not free of oxide, even if they are hot. All oxide and scale must be removed, even if it is necessary to pickle the inserts in acids to remove them.

The inserts will blow if cold because the moisture of the mold condenses on the cold iron, and they will blow if oxidized even if warm, therefore, the iron must be clean and heated to a temperature above 212 degrees Fahr.

Alloys of Aluminum Froth

We are casting manganese bronze propellers, using a horn gate and also pouring down the riser, but it appears we cannot eliminate dross formation on the cope side of the blades. Can you advise proper method of molding to avoid this dross? We have used the best grade of manganese bronze bought from various reliable concerns, as well as our own mixture consisting of the following: Copper, 45 per cent; zinc, 42 per cent; manganese copper, 12 per cent; aluminum, 1 per cent.

To get a clean casting of manganese bronze, or of any other copper alloy containing aluminum, agitation must be avoided while the metal is being poured into the mold. Dross is formed in a manner similar to the production of suds on a solution of soap in water, when such a metal is agitated. The dross on the surface of the blades will cause no difficulty provided the metal is run in at the bottom through cores. A horn gate is not suitable because it is in effect a nozzle from which the molten metal emerges with a jet effect. This is due to the fact that a horn gate tapers thinner towards the casting. In making aluminum bronze castings, when horn gates are used, they always must be placed exactly opposite to the way they are used for red brass. This is a good point to remember in the case of manganese bronze also.

By keeping in mind the tendency of manganese bronze to lather like soapy water, a scheme of gating can be evolved that will introduce the bronze gently and without the formation of the dross which causes the trouble. In general, a bottom gate is best. Read the question "Casting Large Manganese Bronze Bushings" in the November 15, 1921, issue of THE FOUNDRY, for this suggestion led to a successful casting.

Metal Takes High Polish

We require an aluminum alloy for an automobile accessory that should take a high polish. We have tried the standard No. 12 alloy, both ingot and virgin metal, but it drags on the buff, making an unsatisfactory looking article. We will thank you for an alloy that can be used as we desire.

Use the following alloy:

Metal	Weight in Pounds
Aluminum	75
Zinc	20
Copper	5

If any difficulty is encountered in casting this alloy, substitute the following:

Metal	Weight in Pounds
Aluminum	82
Zinc	15
Copper	3

Urges Electric Furnace for Foundry

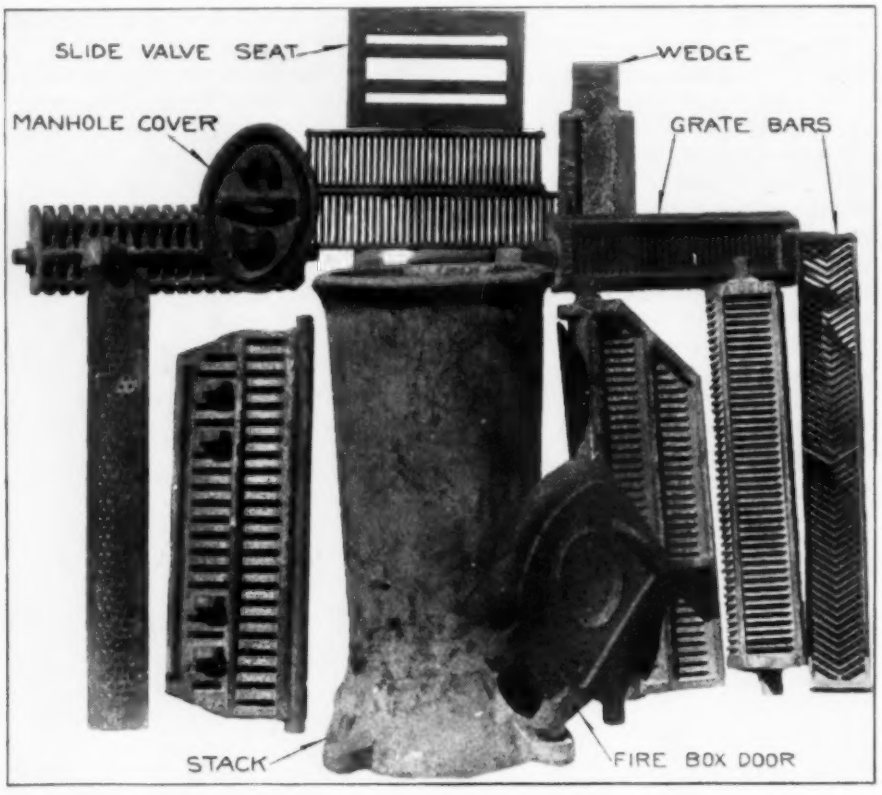
Advantages Often Outweigh Higher Melting Cost—Methods of Introducing Carbon Shown—Intimate Contact Obtained by Putting It on Furnace Bottom Under the Charge

BY THOMAS ROBSON HAY

STARTING first in a small way in the steel making industry the electric melting furnace has gradually made its way into other branches of the ferrous and nonferrous metal industry, and is now aggressively reaching out and into the gray-iron field.

The foundation of successful production of such output as piston rings, etc., is the metal from which they are made. Upon the treatment and refinement of the gray iron depends the successful and economic use of the finished product. Design cannot compensate for improper metal. The increasingly rigid specifications of industry have been forcing the traditional, long established cupola to its utmost. For years the greatest problem for the gray-iron foundrymen has been the control of the iron. This has been generally done in the cupola and now the electric furnace is being put forward as a better melting medium. One objection to the use of the electric furnace for melting or refining gray iron has been its higher melting costs. However, actual experience has demonstrated that this higher cost is more than compensated by the superiority of the metal for certain castings.

Light steel turnings, iron borings, pig iron, and sprues and gates returned from the foundry cleaning floor, are all available for making up an electric furnace charge for gray-iron castings. The proportions of these materials available will depend largely on the local conditions obtaining at the foundry site. If there is an abundance of light steel scrap the charge will be largely made up of steel turnings. If iron borings are available in large quantities, they will, of course, make up a large proportion of the charge. The furnace operator will know what are the proportions of the different grades of scrap available.



LOCOMOTIVE CASTINGS MADE FROM IRON MELTED IN THE ELECTRIC FURNACE

To secure the proper carbon content in the metal, when melted and tapped, sufficient carbon in the form of oilstill coke, ordinary coke, and broken electrode stumps can be added to give the desired carbon content in the metal. Usually, 45 to 60 per cent of the carbon added will be absorbed in the metal bath. That is, if 55 pounds of carbon is the amount required to theoretically give the proper carbon analysis, and it is estimated there will be 55 per cent absorption, 100 pounds of coke must be added.

The carbon is put in the furnace with the first portion of the charge, which is made up of the material containing the lowest percentage of carbon. In this way the material with the least carbon is in as close contact with the carbon as possible. This facilitates the carbonization of the metal. As the arcs melt the charge from the top down in the center of the furnace and from the bottom up on the banks or edges, it is highly desirable that the carbon be concentrated in the bottom of the furnace.

When the electric power circuit to the furnace is closed and the metal begins to melt, it trickles down through the charge until it comes in contact with the carbon. At this point the molten metal begins to absorb the carbon. The amount of carbon which the iron will absorb is dependent on three constants, first, the temperature; second, the length of time the carbon and iron are in contact; and third, the intimacy of this contact. The higher the temperature, the longer the carbon is in contact with the metal, and the closer the contact, the greater will be the amount of carbon absorbed by the metal.

Since the power consumption per unit of metal melted is proportional, among other things, to the amount of time the heat is in the furnace, the time element should, of course, be kept as low as possible. Therefore, it is not desirable to depend too much on the time element to raise the carbon content of the iron. Another reason for a minimum, practicable time element is that the electrode consumption and the refractory wear are also proportional to the time of the heat.

Accordingly, to get the carbon rapidly into the iron, the metal should be worked as hot as possible, and the contact between the carbon and iron should be intimate. However, these desirable production factors should be considered in their bearing on and

relation to others. For example, consideration should be taken of the fact that too high a temperature causes rapid deterioration of the refractories. The temperature which the refractories will stand is the limiting factor in the pouring temperature of the metal.

The extent and the manner in which intimate contact between carbon and metal is beneficial in producing castings of superior quality is not agreed upon by metallurgists. Our experience seems to indicate that the best results are secured when the furnace is operated in such a manner as to keep the carbon under the metal. A small amount of crushed electrode, crushed coke, or other suitable material, bound with tar, is sometimes rammed on the hearth of the furnace. This has been found to be a successful means of dissolving the carbon in the iron. Another aid to carbon absorption is low silicon. Necessarily the iron must have silicon, but when it is made from a charge containing a high percentage of steel scrap, the silicon should be put in at the end of the heat, when the carbon content has been adjusted to the desired figure.

Picks Up Carbon

Steel scrap will easily pick up 2.5 to 2.6 per cent of carbon, even when the carbon is thrown on top of the bath, after the charge has become molten. However, some difficulty is encountered in getting larger percentages of carbon in the iron, especially when it is endeavored to raise the carbon contents above 3.5 per cent. However, this can be accomplished by allowing the iron to remain in the furnace a few minutes longer than usual, meanwhile stirring the carbonizing material into the bath with a dry, wooden spoon.

The matter of control of analysis with certainty is an important one in making gray-iron castings. Close control may be obtained in the electric furnace. The control of carbon has been described. Desired percentages of silicon and manganese are obtained by additions of ferrosilicon and ferromanganese. The electric furnace makes possible the absorption of practically 100 per cent of these two elements by the metal of the charge.

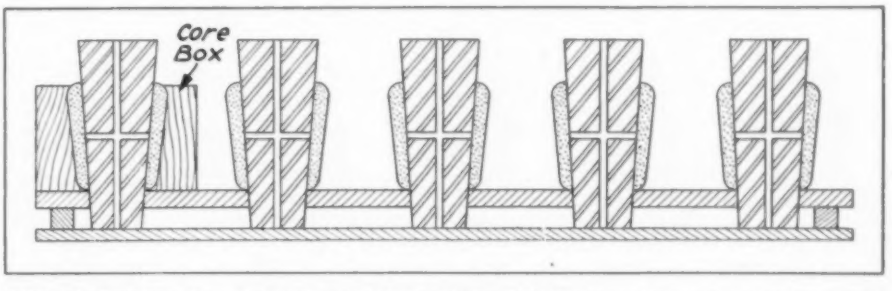
One decided point in favor of the electric furnace and, in fact, one which, in all probability, first led to the use of the electric furnace in gray-iron work, is that no fuel is introduced from which sulphur can be absorbed. The absence of increase in the sulphur contents of the iron is particularly advantageous in casting extremely light work, where the metal must be bright, machineable, and soft. Also, in this type of work the remelt is high and on each remelt there is the added absorption of sulphur, when the iron is melted in the cupola.

The only desirable quality imparted to iron by the presence of phosphorus is fluidity, or brightness. If fluidity is obtained by the use of phosphorus, it is at the expense of softness and strength. By contrast, the electric furnace imparts to the metal a high degree of fluidity, because of the higher temperatures.

Sand Core Is Attached to Iron Mandril

Question—What is the best method for coring out the recess in axle boxes for farm wagons? We use iron mandrils for the bore.

Answer—A sand ring core can be attached to the mandril to form the recess in the axle box. If the mandril is not hollow, drill a hole through it from end to end. Then drill a second hole from side to side at a point that will pass through the first hole and also coincide with a vent passage scratched on the inside center line of the ring core.



THE COREBOX IS PLACED AROUND THE MANDRIL AND THE SAND CORE RAMMED IN PLACE

The center hole in the ring core must be a close fit. Paint a little paste on the inside of the core and drop it over the mandril. It can be adjusted at the proper distance by a gage or by marks on the mandril. If the mandril is hot it will dry the paste, otherwise it will be necessary to place it with the core attached in the oven.

An alternative method would be to place the ring core box around the mandril; ram the core in place and dry it there. To do this properly it would be necessary to provide a core plate having a number of holes just large enough to permit the mandrils to drop through the required distance as shown in the accompanying illustration.

To ream out the holes in the plate accurately entails considerable work and for all practical purposes they may be cored. In this case it will be necessary to provide two plates. The upper plate with the holes separated from the lower plate by suitable blocks. The mandrils rest on the lower plate and the zone exposed immediately above the upper plate is in the correct position for attaching the core.

Malleable Unsuitable for Permanent Mold

By H. E. Diller

Question—For a special job in our factory we are considering the advisability of using malleable-iron molds for casting copper rings. Please tell us whether the molten copper would adhere to malleable iron and whether malleable iron will successfully stand the heat radiated by molten copper. The section of the casting is 1 inch square and the mold is ½ thick.

Answer—The copper would adhere to the malleable iron mold if the surface of the mold was clean and the mold became hot enough. This is proved by the fact that malleable iron can be brazed. Malleable iron to a limited extent would withstand the heat radiated by molten copper, that is, if the section of malleable iron were heavy enough in comparison to the amount of copper poured against it, and the surface was protected by a graphite wash. However, the amount of copper you propose to pour into an iron mold ½-inch thick would soon change the iron against which the copper is poured into white iron, while the outside of the casting would remain malleable. This would set up severe internal strains in the permanent mold and quickly crack the surface against which the copper is poured.

In case you wish to try a permanent mold, we would recommend that you use gray iron with a section 1 to 1½ inches thick, and that the inside of the mold be coated with a heavy graphite wash and dried before use. Under these conditions you might succeed in securing good copper castings economically.

Rolls Molded in Sectional Flasks

Method Is Given as an Alternative to Sweep Molding—Mold Finished in Sections and Clamped Together—Grooves Are Formed by Sectional Loose Pieces and Cutting Away the Sand

BY J. R. HADSUM

PRODUCTION of steel mill rolls as carried on in America is interestingly described in THE FOUNDRY of Aug. 1 and 15. Fig. 11 in the issue of Aug. 15 shows a steel roll with grooves, being molded horizontally with a sweep and bar. This practice may be contrasted with a method employed in the foundry in which the writer works, whereby similar molds are made vertically.

Fig. 1 is a cross sectional elevation of a square flask standing on a bottom plate, clamped as shown. This flask must be of a size suitable for the diameter of the roll, and deep enough to take the bottom neck and wabbler, marked *C* and *D*. *D* is the neck and *C* the wabbler, both loose pieces of pattern.

The first operation after setting the flask and bottom plate consists of setting a 3-inch plug, *A*, through a hole in the center of the bottom plate and ramming a solid bottom, marked *B*, of molding sand, say 8 or 9 inches deep. The remainder of the space around this block of facing sand is filled with floor

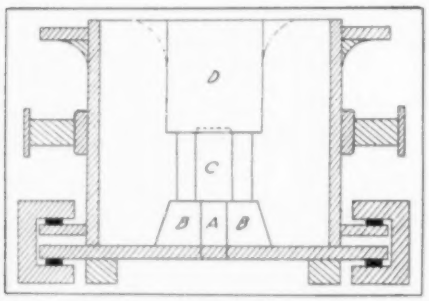


FIG. 1—FLASK FOR NECK AND WABBLER WITH PATTERN IN PLACE

sand and cinders. Vents are carried up through all sections from three corners of the flask. The down gate is placed in the fourth corner after reaching the first parting marked *I* in Fig. 2. A level place is made on the facing sand in the bottom of the flask, Fig. 1, for the wabbler *C*, and it is set central with the 3-inch hole. The reason for this hole is given later.

The neck is tried on the wabbler to get the correct height and placed aside to allow room for ramming the wabbler and making a level surface for the neck. This surface is well studded with nails, then before the neck pattern is

IN LARGE foundries equipped to make steel rolls and sand-cast iron rolls, the usual procedure is to sweep the mold in a full length flask made in two sections bolted together. However, to up-end these flasks a crane with heavy lifting capacity must be provided and the head room in the foundry must be high. This is one of the reasons that might induce a foundry to mold the rolls in a sectional flask in a manner similar to the British practice outlined in this article.

placed back and rammed up to the level of the flask and a parting is made at this point. Pattern section *E*, Fig. 2, is then placed on and a set of loose pieces marked *F* is placed around it as shown. These circles are generally in six sections, one of them having its sides at such an angle as to permit it to be drawn in and release the others, should they be placed where there is no parting, as at *G*. The molders then have a hint for cheeks which will suit the depth of section, *E*. Sometimes they manage with two, never less, often more. If they cannot get the right depth then the parting at II is varied to suit.

Vent Sticks in Corners

The three cheeks are not put on and clamped up at once, it is more convenient to put them on one at a time. The gate stick is placed in the corner where there is no vent stick, before ramming is started. A good thickness of facing sand is placed between the different sets of loose rings as the sand is cut away afterward in order to form the grooves, as shown by dotted lines.

A bed is formed for the loose pieces marked *G* by a suitable sweep working off the top of section *E*. After the flask is filled with sand, space is swept out for the loose pieces *H*. At this stage after clamping all three sections together, using 8 to 12 clamps and making guide marks at *I* ,the parting is made. Section *E* of the mold is lifted off and placed on a soft bed on the floor. This is a convenient arrangement, as another man can now take the neck out of the lower flask, carve it to the curved lines shown on Fig. 1 and nail curved portion. The neck pattern later is used to form the top neck marked *O* in Fig. 2.

After section *E* is set on the floor, suitable cheeks are then selected and molding operations are carried on, as in section *E*, to form section *R* and section *L* may also be molded at this time. Another soft bed is made and the upper sections are lifted off at parting *II* and placed on the prepared bed. This permits finishing section *E*. A spike is driven into each of the curbs *H* which are then withdrawn. The surface of the mold formed by the loose pieces *H* is then given a coat of thick tar paint and sleeked. The space *H* is then filled with

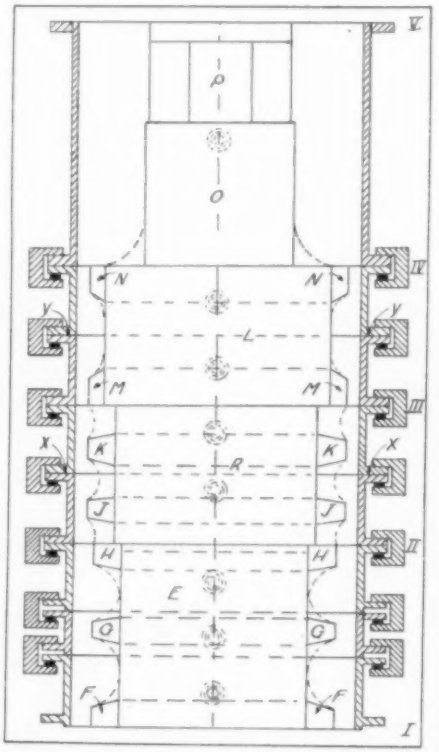


FIG. 2—TWO OR THREE FLASKS ARE CLAMPED TOGETHER TO FORM A SECTION

wet sea sand and about an inch thickness of sea sand is spread over the parting II.

A plate is then rubbed on to this parting and clamped to the flanges of the flasks at *II*, and the section is rolled over the floor. Each cheek has a pair of journals or centers as shown by dotted circles, but as the flanges are

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

ROUTINE ANALYTICAL METHODS

(*Continued from Data Sheet No.* 418)

Routine Procedure—Same as standardization (1 gram for cast iron or 2 grams for steel) covering both the inlet and outlet of the bulb with a short piece of rubber tubing having one end stopped with a short piece of glass rod when not on train, to prevent absorption of moisture or carbon dioxide from the air. If any trouble is experienced from hygroscopy of bulb a counterweight bulb should be used. A bulb is good for at least 40 to 60 determinations with samples of cast iron under 4 per cent carbon. The color of the absorbent changes from greenish to white as it becomes exhausted.

Increase x 27.3 = per cent carbon in cast iron x 13.6 = per cent carbon in steel.

Notes and Precautions—All cast iron samples should pass a 20-mesh sieve before weighing as there are great differences in the carbon and graphite contents between coarse and fine particles and large chunks of steel or iron are difficult to burn completely. Scale, dirt, oil and shavings must be avoided.

The combustion train should be adjusted so there is minimum resistance to the flow of oxygen and all connections properly made. A well set up train using good oxygen will work satisfactorily for months. The first bulb of ascarite is an excellent absorbent for moisture and CO_2, the more common impurities in oxygen. The slag wool is used to catch the iron oxide. If asbestos is used in the combustion tube, it soon becomes clogged up and low results follow. The main action of the concentrated H_2SO_4 is as a dryer. It is also a most convenient indicator of the rate of flow. Calcium chloride and phosphoric pentoxide are good dryers. Potassium hydrate (solution or sticks) is a good CO_2 absorbent.

Ignited sand (lake sand is O. K.) is fully as satisfactory as alundum powder. (Alundum often contains considerable amounts of CO_2 as well as moisture.) The use of a sleeve or protector around the combustion boat is unnecessary. With proper care a vitrified clay tube is good for about 1000 combustions.

The temperature of the furnace, which may be determined by inserting a pyrometer when oxygen is not flowing, should be 900 to 1050 degrees Cent.

The method as given is accurate to closer than 0.02 per cent carbon on a 2.5 per cent United States bureau of standards sample. It is worth while precaution to run a standard about every 26 carbons. The running time per sample can be speeded up to 5 minutes if desired. The above method is based largely on the method of Stetser and

(*Continued on Data Sheet No.* 420)

ROUTINE ANALYTICAL METHODS

(*Continued from Data Sheet No.* 419)

Norton. There are a number of different trains, absorption tubes, etc. which are more or less satisfactory. An excess of *precaution* apparatus generally defeats its own purpose by introducing more connections, corrections, etc. and is worse than useless if first grade oxygen can be obtained.

For routine work the use of factor weights is always convenient. When the factor weight 0.9091 gram is used for carbon determination, the weight of $CO_2 \times \frac{100}{3}$ = per cent carbon.

DETERMINATION OF GRAPHITE

Solutions

Dissolving Solution—1 part HNO_3 (concentrated) to 1 part H_2O (by volume)

HCl Wash—1 part concentrated HCl to 3 parts H_2O (by volume).

NaOH Wash—15 grams NaOH to 1 liter H_2O.

Procedure—Dissolve 1 gram sample in about 40 c.c. dissolving solution. Prepare a filter bed of ignited asbestos in a gooch crucible with removable bottom. Decant iron solution through filter, add graphite and wash with hot water until all iron is removed. Wash several times with hot HCl wash, then with NaOH solution, then thoroughly with hot H_2O again. Dry crucible and contents on hot plate or in oven. Place asbestos plus graphite in combustion boat and finish exactly as carbon in iron.

Alternate procedures which are not recommended to be as satisfactory as the method just given are as follows:

Filter graphite into platinum boat with asbestos filter, dry, weigh, ignite and reweigh.

Dissolve in 1 to 1 HCl, boil 20 minutes, wash with HCl wash, ignite, etc. same as above.

Notes and Precautions—As drilled the fine particles are much higher in graphite than the coarse so the sample must be ground and mixed to obtain accurate results.

(*Continued on Data Sheet No.* 421)

on two opposite sides only, it is not practicable to use the journals except they are in line as the flask as well as the finished molds are handled by hitching slings to the lower journals.

The loose pieces, *F* can be drawn after section *E* is turned over from its original position and the pattern is then withdrawn by the crane. The loose pieces *G* can then be drawn in and the grooves carved to the shape shown by dotted lines. A thick coat of paint, sleeking and a coat of blacking makes the section ready for the oven.

Gaggers are placed in each section and as the molding progresses the gate stick and the three vent pipes are gradually withdrawn as the height of the sand is raised. Section *L* is made in a manner similar to that used in molding sections *E* and *R*. The neck pattern *D* in Fig. 1 marked *O* in Fig. 2 is placed on parting *IV*. The flask for this is generally made up of four plates fastened at two opposite corners with cotter pins so that this top section can be opened easily some 3 or 4 hours after casting to permit of digging sand away from the neck to allow the roll to contract. After this flask is rammed, pattern *P* forming the wabbler and part of riser is drawn; a plate clamped on; suitable marks placed at the partings to act as guides for closing and the flask is turned over so that the neck pattern can be drawn, carved, painted and finished for the drying oven.

An addition to the riser is rammed up in another set of smaller flasks, and a similar addition to the runner is made in a still smaller set of flasks. Each of these sets is generally composed of two or three flasks clamped together. Each section of the mold having been rolled over before drying, with the exception of the bottom neck and wabbler, of course, requires to be rolled over again when closing the mold. The bottom plates that were placed on each section being left on the floor after having the clamps knocked off. When closing, each section is placed to the marks made before parting and clamped securely at each parting line.

The 3-inch hole marked *A* in Fig. 1 is for the purpose of fastening a dummy casting which is inserted into the mold to chill the bulk of the metal in the center.

I often notice when reading Pat Dwyer's extremely interesting articles in THE FOUNDRY that after he and his friend Bill have cast a few jobs they agree "to call it a day and quit." In this case we shall vary the metaphor and "call it a week and have done."

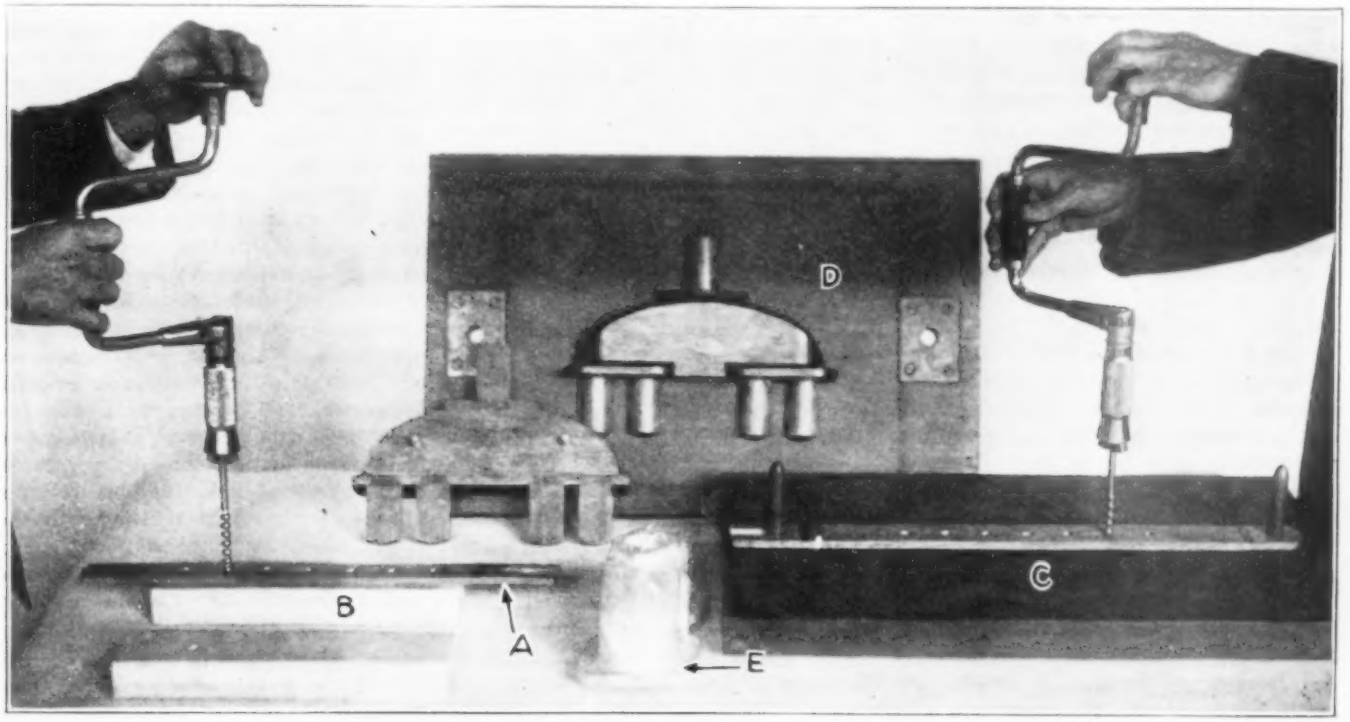
Standardization of Patterns Desirable

BY B. RUPERT HALL

CONSIDERABLE room for improvement exists in methods employed in pattern shop practice. Too often the individual patternmaker is a law unto himself and eagerly strives to work out problems whereby an improvement in his work effectively may be made. Problems essential to pattern making progress constantly are appearing for solution. The progressive spirit of the age demands new ideas and methods that are practical and of commercial value. Standardization offers a solution to problems that have appeared almost impossible in the past. A method for locating dowel pin holes might well serve as a starting point in standardization.

A device which has been used for some time for this purpose is shown in the accompanying illustrations. The gage indicated at *A* is provided with ten ⅜-inch diameter holes, equally spaced 1½ inches center to center. A hole close to one end and a slot at the opposite end serve to locate the gage on the flask or pattern board. The heavy black mark close to each end corresponds to the outline of the flask. This gage may be used for locating dowels from 1½ inches to 15 inches apart and of course the idea may be adapted to cover practically any range of sizes. A small parted pattern was employed in the present instance for purpose of illustration.

To locate the dowels the gage is



A STANDARD GAGE MIGHT BE USED FOR LOCATING DOWEL PIN HOLES

placed on one of the pieces of stock *B*. Assuming that the holes Nos. 2 and 6 represent a suitable distance for the dowels, a ⅜-inch bit is inserted in the wood through hole No. 2 and a hole bored through the piece. The bit is removed and replaced by a dowel pin which projects through gage and stock and keeps them in position while the hole is being bored through the second hole at No. 6. The first piece of stock then is placed upon the second and, using the upper holes for guides, holes are bored part way through the lower piece. The dowel pins and dowels then are placed in the holes in the usual manner after which the two half blocks are joined together and worked down to the required pattern shape.

To mount the pattern on the molding machine board the gage is employed as shown at *C*. It is placed on the board and suitable holes bored through, using the same holes 2 and 6 for guides. The board carrying the pins then is inverted on the board provided with the pin holes and, using the first board for a guide, holes are bored through the lower board. Afterward the boards are separated and a half pattern attached to each as shown at *D*. The casting shown in the center of the illustration at *E* was made from a pattern mounted in the manner indicated and, as in the case of other patterns mounted similarly, the match along the joint line is perfect.

To facilitate the work it is advisable to provide a supply of standard plates with holes corresponding in size to those in the gage. This method of mounting patterns does not increase the work of the patternmaker and greatly facilitates the mounting of the pattern when it reaches the foundry. The foundryman has the option of employing either the hand molding method or the molding machine method.

Pattern Standards

THE general committee on standard pattern practice, organized under the auspices of the American Foundrymen's association and working in conjunction with the American Society for Testing Materials, recently has received the report of a special sub-committee on certain phases of pattern standardization. The report recommends the adoption of certain definite colors for wood patterns to indicate the metal of which the casting is to be made; the sizes of dowel pins and the size of the bits employed to bore the dowel holes; the taper on core prints for all patterns and also the taper on patterns to enable them to be drawn from the sand. The report further recommends that the shrinkage to which metal patterns are made shall be stamped on the runners. Vaughan Reid, City Pattern Works, Detroit, is chairman of the committee.

Melted Aluminum in the Core Oven Fire

By Thomas Nelson

Many years ago when aluminum casting was in its infancy I worked in a foundry claimed by the management to be the most up-to-date and best equipped of its kind in the country. It was not an aluminum shop and many of the methods practiced in the early attempts to handle this metal seemed to indicate that while the shop and equipment might be modern, some of the ideas held by the management were decidely antiquated. The first aluminum for a few small pattern parts was melted in a wrought-iron pot in a blacksmith's fire.

The company secured a large order for a certain class of aluminum castings, set a part of the shop apart for the purpose of making them and placed one of the workmen as foreman in charge of the department. He was not familiar with aluminum practice and as the work was more or less in the nature of an experiment he did not want to install any more equipment than necessary. From eight to ten molders and from three to six coremakers were employed and while the molding facilities were all that could be desired the melting practice was ridiculous.

To save the expense of installing a melting furnace, the metal was melted in a crucible in the core oven coke fire, and if those in charge deliberately had tried, they could not have devised a more expensive or more troublesome method. Extra coke was required to bank up around the pot, time and labor were required to maintain the fire and a great number of cores in the oven were burned on account of the roaring fire. The men had to face intense heat and partial suffocation while removing the pot from the fire and naturally under such conditions the melted metal was not uniform. One pot would be burned and the following pot would be too cold resulting of course, in a large proportion of waste castings.

The contract finally was completed under the foregoing conditions; the gang was dispersed and I was left alone to make any odds and ends of aluminum castings that might be required. Melting the metal in the core oven, with all its attendant hardships, did not appeal to me and I lost no time in devising an easier and more convenient method. I adapted a hot air mold drier which a short time previously had been given a try-out in the shop and discarded as unsatisfactory for the purpose. It consisted of an outer sheet iron shell, with a fire pot inside and with an air space between the fire pot and the shell. Compressed air entered at the top and drove the heat generated by a coke fire in the pot, down through a suitable pipe into the mold.

I had some slight changes made in this device, including an air connection at the bottom instead of the top and, after the fire was started and the crucible charged, I could melt 30 pounds of aluminum in about 20 minutes. For convenience I erected a small platform at one side and found that I could handle the pot nicely alone. I melted several tons of metal in that little furnace and did it in comfort and at low cost.

Two Heats a Day Taken from Cupola

By C. E. Akers

An article which appeared in a recent issue of THE FOUNDRY describing how four heats a day were taken from a small cupola and the comment thereon which was published in a later issue recall to mind a somewhat similar experience of the writer's. The problem in this case involved the production of 60 sets of castings per day, amounting to 10,000 pounds with molding equipment for only 30 sets. After having decided to try two heats a day, the molding time was so arranged as to have the first 30 sets ready to pour at 11 a. m. and the second set ready at 4 p. m.

The cupola employed in this instance was lined to 36 inches. Hand ladles, catching over a continuous stream from a ½-inch tap hole, were used to pour the castings. The first heat was charged and taken off in the usual manner, the blower being left on long enough to insure that all the metal was melted. In addition to the limestone usually employed, a small quantity of fluorspar was placed on each charge to make the slag as fluid as possible. The slag hole was opened after the cupola had been in blast for about 45 minutes. At the close of the heat the breast was knocked out and the remainder of the slag drained out through the opening. This heat averaged about 5500 pounds and was poured off in about an hour.

Preparing for the second heat, the chilled slag was chipped away from around the breast opening and a new breast was rammed into place. The tuyeres were poked open and a suffi-

cient quantity of coke shoveled into the cupola to level the bed up to the proper charging height. The iron on the second heat was hot enough to pour the thinnest castings made. The melting rate was lowered somewhat on account of the condition of the interior of the cupola and the drop was not quite so clean as usual, but no trouble was experienced in getting the cupola ready for the heat on the following day.

It is admitted generally that a cupola heat can be held if necessary for several hours and it might be thought that unnecessary trouble was taken in this case. However, I believe that a little consideration will show that this trouble was justified. The castings were thin, hard to run and required absolutely first class metal. In all probability, iron melted after a long shut down would be high in sulphur, dull and lifeless. Furthermore the small tap hole would have frozen solid and caused additional trouble. The method outlined in the foregoing proved entirely satisfactory and was used continuously for several weeks until the job was finished.

Patternmaking Is Only Means to an End

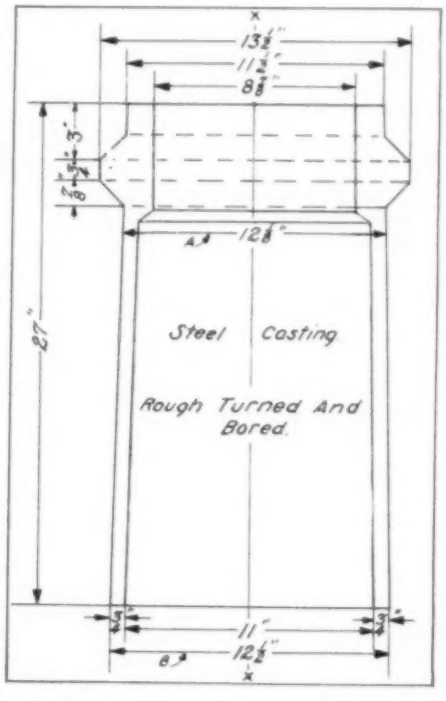
BY M. E. DUGGAN

AT THE first glance the accompanying illustration indicates to a patternmaker little that is difficult in the making either of the pattern or the casting. However, when he learns that the pattern is smaller in diameter at the ring than it is at the bottom, in other words that it has 3/8-inch back draft as indicated by the dimensions *A* and *B* and that the casting is to be of steel with only a roughing cut allowance for finish he may find it necessary to revise his opinion.

I made the pattern split through the center to be molded on its side. The only information I had to go by was the drawing and it carried a note supplemented later by verbal instructions to allow just enough stock for a rough cut finish. The job was in a hurry and I made the pattern in what I considered the easiest and shortest manner. The question as to whether the pattern was conducive to the production of a sound and satisfactory casting did not trouble me. I was passing the buck to the foundryman.

When the pattern reached the foundry it was held up while a 3-inch print was tacked on the scanty 2-inch print I had provided at each end. In an effort to use the pattern as supplied, one casting was made and poured on its side, but it was a waster. The molder then took the pattern and nailed both halves together and molded it on end, ring end up as shown in the illustration. To overcome the back draft and get the pattern out of the sand he kept rapping the pattern with a sledge hammer as he drew it up until the diameter at the top of the mold was equal to that at the bottom. This method increased the amount of metal which had to be removed in the machine shop, but it also produced a solid casting and that was the only point in which the foundryman was interested. He simply followed instructions to get a good casting in the shortest possible time.

Was it not my business or for that matter the business of any patternmaker to know how a pattern should be made to meet foundry requirements and insure the production of a good casting? In this case one with just enough material to finish up with a roughing cut instead of about 1 inch of surplus material around the top and tapering down



THE CASTING IS LARGER AT THE BOTTOM THAN IT IS AT THE TOP

to nothing at the bottom. If the job had been made on its side I should have known that a 2-inch print at each end was too short to support a heavy core 11 inches in diameter and over 2 feet long. If the reader is a patternmaker I would ask him to consider the following points before definitely committing himself to an opinion on how this pattern should have been made.

What do you consider the right allowance for a rough cut finish on a steel casting this size?

If only one casting was wanted would you make a split pattern to be molded on its side? Can you give a practical reason for your chocie?

Suppose the drawing and instructions called for rough cut finish but the molder insisted on a solid pattern to mold on end, would you taper the pattern on the outside the opposite from that shown in the drawing, to facilitate the molding, but which would increase the amount of stock to be removed in the machine shop, or would you make the pattern so that the mold could be checked off? Would the added cost of making the pattern in this way be off set by the saving of extra metal in the foundry and the extra tool work in the machine shop?

A skeleton core box is made easily and quickly and perhaps where only one core is required it is an economical device, but cores can be made in a built up half core box at about the rate of 4 to 1 and generally speaking they are truer to size.

Securing Data on Soil Pipe Fittings

By H. E. Diller

Question—Where can we secure data as to the weights of the various sizes of soil pipe fittings now on the market?

Answer—Standard weights for soil pipe fittings are given in the specification on soil pipe fittings of the American Society for Testing Materials, 1315 Spruce St., Philadelphia. Copies of these specifications are printed in the A. S. T. M. Standard and also in THE FOUNDRY of Sept. 1 and 15, 1920. You probably can have access to copies of THE FOUNDRY or of the A. S. T. M. Standards at your local library.

I. D. Adams, formerly connected with S. Obermayer Co., Chicago, has opened an office at 204 Seitz Bldg., Syracuse, N. Y. as manufacturers' agent handling foundry equipment and supplies. Mr. Adams also has been appointed representative for the E. Reed Burns Mfg. Corp., platers and polishers supplies.

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Experience Required to Handle Men

CHAUNCEY DEPEW, reminiscent in a series of articles recently appearing in a popular periodical, states that the only strike which occurred on the New York Central lines during the years of his administrative control went into effect while he was absent in Europe and while executive powers were vested in a comparatively young man. He pays high tribute to this officer as a master of technical and business detail connected with the profession of railroading; but says that the error of judgment which lost millions in revenue to the road and a corresponding amount to the employes, was due to the fact that the young man only had a theoretical knowledge of one of the most important factors involved in conducting the affairs of a large industrial enterprise, the experience in handling men. The young man, fundamentally clever and lacking in that one point through no fault of his own, but solely through a system of training which ignored that particular essential, profited by his mistake, and later, equipped with maturer judgment and experience, when he went to another road made a conspicuous success of his administration. Mr. Depew did not present this incident as an argument for, or against, strikes. He simply cited it to bear out his contention to the effect that co-operation between management and men is essential to business success and that to have co-operation, a closer relationship is necessary and further, that the burden of promoting this closer relationship clearly is up to the management. From their status as executive heads, the officers are in a better position to consider questions of policy in their broader aspects and it should be their duty to lay these policies before the men in a manner that will enlist their whole-hearted support. To do this the officers should be familiar with the employe's viewpoint.

Boiled down to its essentials and applied to the foundry industry it means that those in active charge of operation should have a knowledge of technical and mechanical detail at least equal to that possessed by those who do the actual work. In addition, the supervising force should have a knowledge of human nature sufficient to realize that all workmen are not alike either in their mental or physical capacity. A prolific source of difficulty, especially among young executives who have not had the advantage of experience in the ranks, is the assumption that one workman is like another in the same sense that one piece of machinery is like another and that leads to the corollary that two men should do twice as much work in the same time as one man. Under certain circumstances the assumption is justifiable, but exceptions exist to such an extent that nothing short of actual experience will qualify a man to set up in judgment in many cases. For instance to consider an extreme case, a dozen men clustered around one typewriter would not turn out any more work in a day than one man working alone. The three fundamental factors of manufacturing operation are time, labor and equipment and actual experience on the supervisor's part is necessary to secure the best results from this combination. Some men have a natural gift along this line, but the majority gain knowledge through time and actual experience.

Trade Outlook in the Foundry Industry

MORE tangible evidences are offered daily tending to show improvement in the market for castings. While the immediate effect is not great, measured in tonnage of orders, a slight quickening is evident and a much more hopeful outlook is offered for the spring and summer than at first was expected. The general tone of the inquiry prevalent is better; the purchases of metal and fuel are increasing; and the hours per week of operation in foundries of all classes are gaining. This may not be apparent to those not directly in the wash of the tide; but the tendency is toward improvement.

Take More Iron

One of the most satisfying evidences of betterment is in the increased purchases of iron by foundries throughout the country. True, stocks have been depleted even under the curtailed operations which have prevailed and buying was expected in the early spring. Further, the attractive prices offered during the past few weeks have presented an inducement hard to resist. However, considering the present financial state of many establishments, buying for the future and particularly unless some immediate prospects of using the iron were presented, probably would not be indulged in to a marked extent. In the Pittsburgh district foundries which formerly purchased as small as 50 ton lots of iron for immediate needs, now are buying from 300 to 500 tons and inquiring more earnestly for future deliveries. Radiator and sanitary ware manufacturers are buying in lots of several thousand tons for March, April and May delivery. In this connection, it is interesting to note the steady advance in demand for castings for plumbing service. According to a report of the department of commerce, 41,993 bathtubs were ordered in December and 58,420 in January and lavatory orders increased from 49,961 to 80,124 between the months noted.

Prices of Raw Material for Foundry Use

CORRECTED TO FEB. 23

Iron		Scrap	
No. 2 Foundry, Valley	$18.75 to 19.00	Heavy melting steel, valley	$14.25 to 14.75
No. 2 Southern, Birmingham	15.00 to 16.00	Heavy melting steel, Pitts.	13.50 to 14.00
No. 2 Foundry, Chicago	20.00	Heavy melting steel, Chicago	11.50 to 12.00
No. 2 Foundry, Philadelphia	20.85 to 21.25	Stove plate, Chicago	14.00 to 14.50
No. 2 Foundry, Buffalo	18.50 to 19.00	No. 1 cast, Chicago	14.50 to 15.00
Basic, Valley	18.00	No. 1 cast, Philadelphia	16.50 to 17.50
Basic, Buffalo	18.50 to 19.00	No. 1 cast, Birmingham	16.00 to 17.00
Malleable, Chicago	19.50 to 20.00	No. 1 cast, Buffalo	16.25 to 16.50
Malleable, Buffalo	18.50 to 19.00	Car wheels, iron, Pittsburgh	14.50 to 15.00
Coke		Car wheels, iron, Chicago	15.00 to 15.50
Connellsville foundry, coke	$4.00 to 4.75	Railroad malleable, Chicago	12.75 to 13.25
Wise county foundry, coke	5.50 to 5.75	Agricultural mal., Chicago	12.75 to 13.25
		Railroad malleable, Buffalo	13.00 to 14.00

Jobbing Improved

For the first time since the depression began, a marked improvement is noted in the operation of jobbing foundries. This particularly is true of the light weight gray-iron shops. The requirements upon which these orders are based, vary widely, with municipal castings predominating. Automotive castings, too, are slightly more in demand. Some of the foundries making this class of work, in Ohio and Michigan are increasing their operating schedules each week, mirroring the conditions in the consumer manufacturing plants. Steel foundries, in general, share in the improvement noted in other lines, but in a less degree. Prices for steel castings are keenly competitive and eagerness for business every place is evident. Malleable foundries anticipate a marked improvement in tonnage output for February, even considering the short month. January was slightly better than December and orders are increasing in pace with the automotive and railway demand. Large inquiries for cast-iron pipe from some of the leading cities are expected. Cleveland will advertise for bids probably for March 15, on the first 1½ miles of a 9-mile requirement of 60-inch pipe for which cast iron will be considered with other types.

Car Orders Increase

Since the present buying movement started a few weeks ago, about 20,500 cars have been ordered in the Chicago district alone. New inquiries are constantly developing, some 10,000 cars being in prospect from western lines. In the East, orders which are impending will include about 4900 for domestic and 4800 freight cars for foreign service. In addition some 1500 mine cars will be placed. This increasing demand, coupled with the repair work which has been increasing during the past few months is furnishing a steadily growing tonnage of castings to malleable and steel foundries. That this buying movement was not launched before it was needed is evident from the surplus car figures. The week of Feb. 1 registered a decrease to 296,659 surplus cars against 330,681 for Jan. 23; while the previous week's figure was 396,192 cars. Although the slight increases in prices for farm products are taken to indicate better prospects for the summer and fall season, little optimism is expressed regarding spring buying. According to compilations from a recent questionnaire propounded by the *Implement & Tractor Journal,* 90 per cent of the dealers in farm implements are selling at about cost, five per cent are taking a profit and the remainder are taking what they can get. Sixty per cent of the dealers who replied, report that they have taken but few contracts for 1922 season. Little demand for sugar machinery either from the south or Cuba is noted. However, the China National Sugar Refining Co., Shanghai recently sent representatives to purchase American machinery.

Nonferrous Prices

Nonferrous prices based on New York quotations in the *Daily Metal Trade* for Feb. 23, follow: Casting copper, 12.50c to 12.62½c; electrolytic copper, 13.00c; Straits tin, 29.12½c; antimony, 4.40c, lead, 4.70c; aluminum, No. 12 alloy, producers' price, 19.00c to 19.20c, and open market, 13.00c to 15.00c. Zinc is 4.50c, E. St. Louis.

Personal

Edwin W. Smith of the H. B. Smith Co., Westfield, Mass., has been elected president of the Westfield chamber of commerce.

D. W. Pratt has been appointed sales agent by the United States Cast Iron Pipe & Foundry Co. for its new branch office opened at 604 Interstate building, Kansas City.

C. Rogers has been made night superintendent for the Monroe Steel Casting Co., Monroe, Mich. Mr. Rogers formerly was superintendent of the Michigan Gray Iron Casting Co., Detroit.

Roland T. Hungerford continues as general sales manager of the stoker division of the Gibby Foundry Co., East Boston, Mass., which recently was purchased from the Files Engineering Co., Providence, R. I.

Martin Harder, formerly superintendent, the malleable department, Chain Belt Co., Milwaukee, and more recently connected with the Saginaw Malleable Iron Co., Saginaw, Mich., has become affiliated with the South Side Malleable Castings Co., Milwaukee.

Robert M. Leach, treasurer of the Weir Stove Co., Taunton, Mass., has purchased a large tract on West Water street, adjoining the Taunton river and will open it as a park as a memorial to the late William E. Walker, one of the founders of the company.

W. G. Ireland, who for the past 10 years has been sales manager of the Jamison Coal & Coke Co., Pittsburgh, has relinquished those duties and has been elected vice president of the Commonwealth Fuel Co., with principal offices in the Oliver building, Pittsburgh.

C. D. Sargent recently joined the sales force of the Abrasive Co., Philadelphia, manufacturer of artificial abrasives and grinding wheels. Mr. Sargent's headquarters are at the Chicago store of that company, 566 West Washington boulevard. About 20 years ago Mr. Sargent had charge of the grinding department of the Peerless Machinery Co., 44 Binford street, South Boston, Mass. His original experience, however, was gained at the plant of the Brown & Sharpe Mfg. Co., Providence, R. I. During 1906 Mr. Sargent joined the engineering force of the Carborundum Co., Niagara Falls, N. Y. He traveled extensively devoting his efforts to adapting carborundum wheels to precision grinding operations. Later he was transferred to the company's sales force making his headquarters in Detroit. He resigned from the Carborundum Co. about two years ago to devote himself to automotive engineering problems.

Address Foundrymen of Pittsburgh

Pointers on cupola practice, with suggestions for better and more efficient foundry operation were given by Pat Dwyer, engineering editor of THE FOUNDRY, at the regular monthly meeting of the Pittsburgh Foundrymen's association, held at the General Forbes hotel, Feb. 20. Mr. Dwyer emphasized the importance of giving as much attention to the analyses of sands as to the analyses of pig iron and called the attention of the members to the oft-repeated error of using too much coke in the melt. He referred to the shiftless methods in some foundries which often leads to too much iron being melted in the heat for the particular job in hand. Mr. Dwyer interspersed his informal talk with humorous anecdotes and references to his own past experiences, both as a practical foundryman and as an editor. A large number of members and guests were present at both the dinner and meeting which followed. These were presided over by Vice President Samuel B. Cuthbert of the Braddock, Pa., works of the Carnegie Steel Co., F. H. Clay, of the Allegheny Steel Co., the organization's president, being absent.

Fire Damages Sand Mixer Manufacturing Plant

The plant of the Blystone Mfg. Co., Cambridge Springs, Pa., manufacturer of sand mixing equipment was badly damaged by fire Feb. 12. The loss is estimated in excess of $100,000. Despite the severe handicap, the company secured temporary quarters and was in production within two days of the fire. It is stated by the officials that steady improvement warrants the belief that there will be no delay in meeting current requirements both for new machines and for service.

Addresses Steel Founders

W. W. Sanderson, general sales manager of the Carborundum Co., Niagara Falls, N. Y., discussed the development of sales possibilities at a recent meeting of the Steel Founders' association, held at the Roycroft inn, East Aurora, N. Y. The steel man expressed a strong confidence in the early resumption of active business and predicted that 1922 would prove close to a normal and profitable year.

Obituary

Henry W. Bullard, treasurer of the Poughkeepsie Foundry & Machine Co., Poughkeepsie, N. Y. died Feb. 4.

Richard H. Rice, general manager of the Lynn, Mass., plant of the General Electric Co., died Feb. 10, at a camp on Lake George. Mr. Rice was born 58 years ago in Bucksport, Me., and graduated from Stevens institute of technology. He later became a member of the Rice-Sargent Engine Co., Providence, R. I. About 18 years ago, he assumed charge of the steam turbine department at the Lynn works of the General Electric Co. and later took full charge of the plant as general manager.

Space Reservations Grow For Rochester Exhibit

Exhibitors at Rochester, N. Y. foundry equipment show in the week of June 5 in conjuction with the American Foundrymen association's annual convention, are requested by Manager C. E. Hoyt to indicate the approximate number of square feet they will require as soon as possible. Applications were in hand for 21,567 feet, a little more than two-fifths of the available space in the three buildings on Feb. 15. This does not include 48 firms which have indicated their intention to be represented but not the space required. With nearly 150 of last year's exhibitors not yet heard from, arrangements are progressing rapidly.

Visits European Foundry Establishments

Franklin G. Smith, vice president of the American Foundry Equipment Manufacturers' association and president, the Osborn Mfg. Co., Cleveland was tendered an informal luncheon at the Queen's Hotel, Birmingham, England, Feb. 6 by a group of British foundrymen interested in the exhibition of foundry and shop equipment which will be held in Birmingham, June 15 to 24. This exhibition will be under the auspices of the Institution of British Foundrymen and the British Cast Iron Research association. The plans for the exhibition, which are now well under way, were discussed at the luncheon.

In addition to Mr. Smith and M. W. Zeman, general European director of the Osborn Mfg. Co., Paris, those present included H. Field, John Harper & Co., Ltd., Willenhall, president of the Birmingham branch of the I. B. F.; F.

J. Cook, Rudge-Littley, Ltd., West Bromwich, past president of the I. B. F.; J. E. Fletcher, director of research association, Birmingham; D. Howard Wood, managing director, Constructional Engineering Co., Ltd., Birmingham; William O'Keefe, proprietor, Adaptable Moulding Machine Co., Birmingham; and H. Cole Estep, European manager, THE FOUNDRY.

Mr. Smith and Mr. Zeman are visiting various industrial centers in England and on the continent with the expectation of returning to the United States at the end of March.

Sand Blast Unit Adapted for Small Plants

What is said to be a thoroughly practical sandblast so small that it can be picked up and carried from place to place and yet capable of doing any work within its capacity as efficiently as any of the larger installations, recently has been placed on the market by the Pangborn Corp., Hagerstown, Md. The machine consists of a suction type gun with the blast action controlled by a trigger in the handle. Compressed air passing through the air jet creates a vacuum by which either sand or metallic abrasive is brought from the hopper to the gun body which forms a mixing chamber for the air and abrasive. Here it is given a swirling action as produced by the rifling in a gun barrel which increases the effectiveness of the blast stream. The quickly interchangeable nozzles adapt it for use in plants with little work or with a small available volume of compressed air. The device operates on any pressure from 5 pounds to 100 pounds. The manufacturer also supplies a small cabinet if necessary, similar to that shown in the illustration, which can be set over the hopper of the machine. It is claimed that this is the most economical method of cleaning small parts, since it furnishes a complete, self-contained, continuous cabinet sand blast at a low initial cost.

A SMALL CABINET WHICH CAN BE SET OVER THE HOPPER CONVERTS THE DEVICE INTO A CONTINUOUS SAND BLAST

Approve New Safety Code

A new safety code for the use, care and protection of abrasive wheels has recently been approved by the American Engineering Standards committee and released for publication. The code was prepared under the rules of procedure of the American Engineering Standards committee and has as its sponsors the International Association of Industrial Accident Boards and Commissions, and the Grinding Wheel Manufacturers association of the United States and Canada. These sponsors appointed a sectional committee to draft the code, consisting of 28 members representing various branches of both federal and state governments, several national manufacturing associations, a number of individual employers, associations of employes using grinding wheels, several technical societies, insurance associations and others interested in the manufacture or use of grinding wheels. Dr. L. W. Chaney of the United States bureau of labor statistics is chairman of the sectional committee, and A. Rousseau of the Norton Co., Worcester, Mass., is secretary.

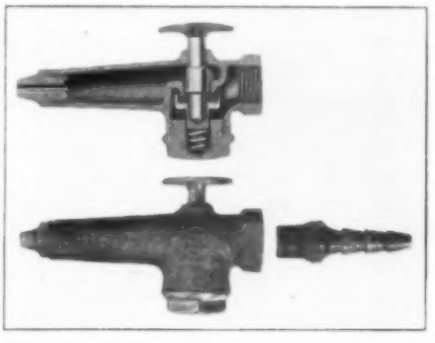
The code is now being printed and will be ready for general distribution about the middle of March, 1922. Copies can be obtained from any grinding wheel manufacturer on request.

Completes Big Crane for the Government

The Cleveland Crane & Engineering Co., Wickliffe, O., has completed a crane of unusual specifications for the United States government armor plate plant at Charleston, W. Va. The runway of this crane is 165 feet above ground and the pit is 100 feet below the floor level. It has a span of 104 feet, a capacity of 75 tons, and is driven by two 20-horsepower motors. The hoisting speed is 50 feet per minute, fully loaded, and the lowering speed is 100 feet per minute, under the same conditions. Another interesting feature of its design, is its ability to stop a full load descending at the rate of 100 feet per minute in the unusually short space of a single foot. The crane is the double bridge drive type and is pulpit operated.

Gun Designed To Supply Blast of Air

The brass air gun shown in the accompanying illustration recently has been perfected and placed on the market by Jenkins Bros., New York manufacturers of valves. The renewable disk with which this air gun is fitted is an innovation in equipment of this kind and it is stated, is especially adapted for air service. The disk forms a perfect contact with the seat and takes up the wear incident to hard and constant usage. The manufacturer states that this type of air gun is finding wide use in foundries for blowing off cores, cleaning coreboxes, flasks, patterns and for general dusting. It is used in machine shops for blowing off chips, borings, filings, trimmings and for cleaning tools, taps, dies, etc. It also is used in wood working mills, textile mills, electrical stations, garages and in fact everywhere a blast of air is required.



AIR GUN AND NIPPLE FOR HOSE CONNECTION, EXTERIOR AND SECTIONAL VIEWS

Eye Defects Source of Avoidable Waste

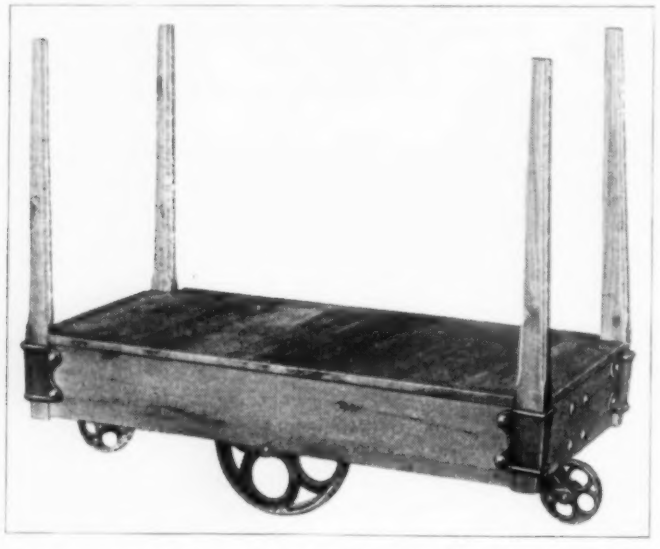
Eye accidents as a source of avoidable waste have been investigated by the American Engineering council. Statistics show the total number of industrial blind in the United States to be 15,000 or 13.5 per cent of the total blind population. The eye it is declared is involved in 10.6 per cent of all permanently disabling accidents. According to the report, eye accidents have been reduced 85 per cent in some plants by the use of goggles. Subnormal vision and faulty lighting are claimed to be responsible for the defects.

An examination of 10,000 employes in factories and commercial companies found 53 per cent with uncorrected faulty vision. Of 675 employes in a

typewriter factory, 58 per cent were found to need glasses. One estimate placed the loss due to faulty conditions above the entire cost of illumination. From 446 plants studied only 8.7 per cent were in excellent condition, and the others were graded as follows: 32 per cent good, 29.1 per cent fair, 18.8 per cent poor, 3.5 per cent very poor, 7.8 per cent partly good and partly fair. Improper lighting was said to decrease output 2 per cent in steel plants and 10 per cent in plants where the operations are on smaller pieces. The fact was also pointed out the cost for providing adequate illumination for the entire industry would amount to 1 per cent of the total wages.

Supplies Truck Hardware

The Oliver Machinery Co., Grand Rapids, Mich., recently has developed a truck for use in furniture factories, pattern shops and other wood working shops, but instead of selling the truck complete it is prepared to furnish the complete set of hardware together with a working drawing which will enable the local workmen in any wood-working plant to assemble the truck for themselves. The accompanying illustration shows the assembled truck and also the individual hardware parts which enter into its construction.



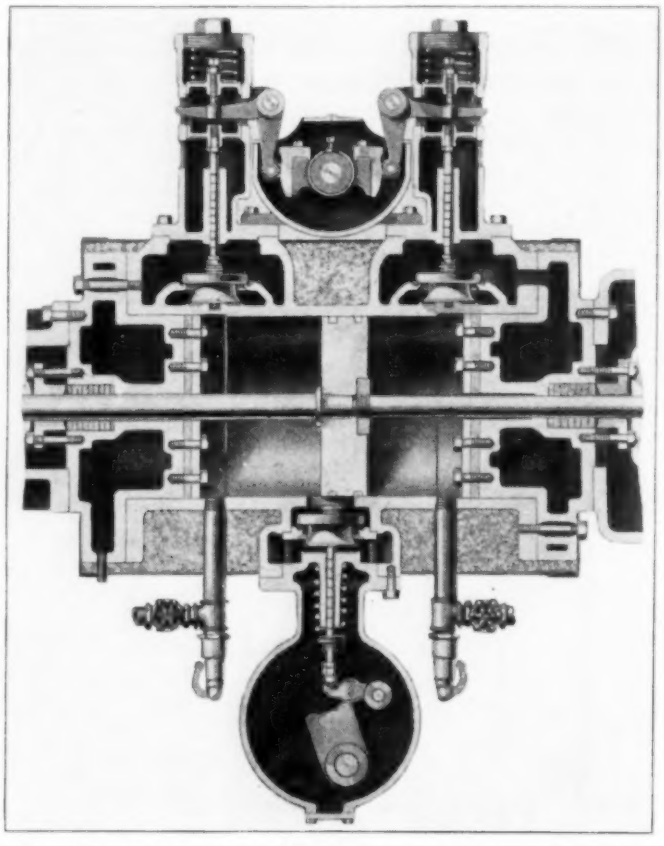
A VIEW OF THE FACTORY TRUCK COMPLETELY ASSEMBLED

It is claimed that this method will effect a considerable saving. The initial cost of the hardware is stated to be little above a foundry basis. It weighs considerably less than the truck and may be shipped under a lower freight classification.

Zircon, the silicate of zirconium, melts at about 4000 degrees Fahr. and is almost impervious to the action of slags.

Air Compressor Driven by Superheated Steam

Among the merits stated by the Chicago Pneumatic Tool Co., for a new type of steam driven air compressor shown in the accompanying illustration are that it is extremely economical in steam consumption and that it meets in a satisfactory manner the conditions imposed by superheated, high pressure steam. The steam cylinder is so designed and constructed that initial condensation is almost entirely eliminated. The exhaust steam does not wash back, leaving through a port in the center of the cylinder. The exhaust is controlled by a patented steam-tight poppet valve which opens when the piston is near the end of its stroke and closes again if the machine is running non-condensing when the piston covers the port on the returning stroke. When running condensing, the valve closes early in the return stroke.



SECTIONAL VIEW OF STEAM CYLINDER SHOWING DETAILS OF VALVES

In addition to effecting a material saving in steam consumption when running non-condensing, the design permits of a much shorter cylinder and shorter piston, hence the weight of the reciprocating parts is materially reduced, there is less friction and the cylinder can be lubricated more easily. The valve problem has been solved by the adoption of the patented Skinner steam tight doubled seat poppet valve for both admission and exhaust. It is stated this valve will remain steam tight indefinitely and will seat regardless of the pressure of temperature under which the cylinder is operated. It is claimed that this valve has been known to have kept steam tight with one grinding with 159 pounds pressure and 150 degrees Fahr., superheat and also with saturated steam at 100 pounds pressure. No lubrication is required.

The governor is mounted in the fly wheel and is operated by centrifugal force and inertia. The governor arm is connected to the steam valve eccentric and by changing the throw of the latter, it changes the point of the cutoff of the steam entering the cylinder. Regulation of the machine is effected by two-step capacity control; two differential unloads connect with the inlet valves and reduce the capacity of the compressor in two steps. One unloader holds open the inlet valves on the crank end of one cylinder and the head end of the other; the second unloader holds open the inlet valves at the opposite ends.

Several plans are on foot to give employment to idle workers in Austria. The railroad administration intends to employ, as soon as credit can be obtained, 600 metal workers and 400 carpenters and coppersmiths in the installation of safety devices, and the erection of buildings. It is also planned to institute street, highway and telephone improvements.

Foundry Equipment Inquiry Varied

Improved Conditions Govern in Those Regions Favored by Recent Orders for Castings—Few New Foundry Projects in Sight for Spring Construction

MORE active inquiries and an increase in orders for foundry equipment is noted in some localities, particularly in Pennsylvania, Ohio and West Virginia, while in the East and some of the Mississippi Valley states are governed by the same disinterested conditions which have been evident for several months. Better conditions in the foundries making railway cars and supplies are reflected in the orders for machinery and equipment, centering in the regions where a pickup is noted. New projects are scarce, but that some new foundries are in prospect is encouraging. Frank D. Chase, Inc., Chicago, has completed plans for a new foundry for the Bucyrus Co., South Milwaukee, Wis. The Studebaker Corp. of America, South Bend, Ind., is reported considering the construction of an extensive modern foundry. The Murphy Valve Co., Inc., Majestic building, Columbus, recently has been incorporated to manufacture valves and steamfitters supplies. This company will not engage in manufacture at once, but contemplates this move later. The Canadian Car & Foundry Co., Montreal, is seeking a site for a plant in Toronto. Recent inquiries for electric melting units have been of a better character. The Bario Metals Corp., New York, will install four new electric melting furnaces purchased from F. J. Ryan & Co., Philadelphia.

Activity in Pittsburgh District

MORE activity is noted in foundry equipment circles in the Pittsburgh district than has been present at any time during the past year. This not alone is confined to inquiries, of which there are a large number current, but actual sales are more numerous and in addition inquiries before sellers appear to be more alive and give more promise of early closing than formerly was the case. A new foundry in the Pittsburgh district is negotiating for the installation of complete equipment, having been granted property by a chamber of commerce for its building. This equipment will include two 108-inch cupolas, a motor-driven blower, sand machinery, flasks, etc. The Clifton Pratt Co., 1224 West Eighth street, Cincinnati, is inquiring for four tumbling mills, 20-inch or 36-inch, with or without exhaust; one 36-inch or 42-inch cupola, 5 or 7-ton per hour capacity; and one sand blast outfit. A foundry in Ohio near Columbus is obtaining quotations on five hand-squeezer molding machines from Pittsburgh sellers. The Keller Foundry Co., Willow street, Knoxville, Tenn., wants a band saw, and the latest inquiry for an electric furnace is reported from the Guyan Machine Shops, Logan, W. Va., for brass melting purposes. The Sharpsburg Foundry Co., Sharpsburg, Pa., in addition to two 10-ton yard cranes, wants a cupola, flasks, etc. Several other foundries are seeking cranes including the American Car & Foundry Co., Huntington, W. Va., which wants two 10-ton electric cranes with 90-foot span, and the Lorain Steel Co., Johnstown, Pa., wanting two 5-ton and one 10-ton mill type cranes for its steel foundry's shake out floor. This company has closed with a Pittsburgh seller upon a number of flasks, a turn table, tumbling barrel, two 4000-pound buggy ladles, and four 600-pound trolley ladles. A local seller also has disposed of a motor-driven blower to a foundry in Washington, Pa., and a motor-driven testing machine to be shipped to South America. During the past two weeks considerable improvement has been noted in the molding machine industry and inquiries before the trade are fairly numerous. In addition to the one already referred to, the Commonwealth Steel Co., Granite City, Ill., has an inquiry out for several machines on which action soon will be taken. The Herman Pneumatic Machine Co. recently has installed two molding units for the Lima Locomotive Works, Lima, O., and another order recently received by it from the National Radiator Co. in New Castle, Pa. One order just received by this interest involves two large rollover machines bought through the National Supply Co., Toledo, O., for shipment to the Union Tool Co., Torrance, Cal. One encouraging feature of this prospective molding machine business is that so much of it gives promise of being closed within 30 days.

Dullness Continues in Chicago

WHATEVER improvement in demand for foundry equipment and supplies was noted early in the year has receded and the situation now is as dull as at any time. While more foundries are operating than at the beginning of the year there does not seem to be additional business, simply a better distribution, often obtained by sacrifice of profits. Equipment and supplies are being bought only when absolutely essential and as a rule purchases are kept at a minimum. Inquiries coming to dealers in many cases die out before they can be converted into orders. The Cadillac foundry is proceeding and steel erection will be started shortly, August 1 being set as the date of its completion. Other new work in the West is lacking. The proposed foundry for the Haskell & Barker Car Co. at Michigan City, Ind., seems to have been blanketed by this company's merger with the Pullman Co. A maker of molding machines recently shipped an order of moderate size to England and a few machines to France. Domestic buying has been lacking. Some demand has been met recently for ladles and an occasional cupola has been sold, but interest lags.

Inquiry Steady in the East

SELLERS of foundry equipment report that business over the past fortnight has slowed up somewhat and that February, on the whole, has not made as favorable a showing as January. Such buying as has prevailed has been scattered and made up principally of orders for single items. However, inquiry has been well maintained, indicating considerable equipment will in all likelihood be purchased as soon as conditions become more settled. At present, while some foundries specializing in particular lines of work, such as pipe and sanitary ware, are operating at around normal, others, the jobbers generally, are still running along at around 25 to 35 per cent of capacity. At the same time, there is little new construction necessitating active equipment. The American Car & Foundry Co., 30 Church street, New York City, is inquiring for 600 tons of structural steel for an addition to its plant at Huntington, W. Va., but as far as can be learned, little foundry equipment will be required. While Booth & Flinn, Ltd., New York City and Pittsburgh, are low bidders on

the general contract for erecting the New York-New Jersey vehicular tunnel, the formal contract has not been awarded owing to legal complications over property in Jersey City, and consequently, the matter of who will manufacture the segments continues in the air. Some interests are of the opinion that the subcontracts will be placed principally with those plants which have done work of this character heretofore and that consequently, they will have considerable of the necessary equipment already installed. However, it appears that in any event, and even though the concerns receiving the subcontracts for segment work already have on hand the special equipment desired, there will be considerable foundry equipment of a general character to be purchased.

What the Foundries Are Doing

Activities of the Iron, Steel and Brass Shops

Capitalized at $50,000, the Boggs Valve & Specialty Co., Okmulgee, Okla., recently was incorporated by P. W. H. Boggs and others.

The capital stock of the Alliance Brass & Bronze Co., Alliance, O., recently was increased from $15,000 to $100,000.

The Stoughton, Wis., works of the Moline Plow Co. has resumed operation of its gray iron foundry for a limited period.

The Gibby Foundry Co., East Boston, Mass., has bought the stoker division of the Files Engineering Co., Providence, R. I.

Contract has been awarded by the Frick Co., Waynesboro, Pa., manufacturer of agricultural machinery, for the erection of an addition to its plant, to be one story, 50 x 100 feet.

The Rhode Island Malleable Iron Works, Providence, R. I., is expected to start work soon on the erection of a new factory building, to be one story, 67 x 252 feet.

Capitalized at $40,000, the T. Tomlinson Foundry Co., Ltd., Toronto, Ont., recently was incorporated by Kenneth D. McKenzie, Hugh E. Martin and L. M. Taylor.

The United States Cast Iron Pipe & Foundry Co. has opened sales offices at 604 Interstate building, Kansas City, Mo., in charge of D. W. Pratt as sales agent.

The plant of the Berry Engineering Co., 610-28 Crosby street, Chester, Pa., manufacturer of machinery and parts, recently was damaged by fire. The loss was estimated at $100,000.

The Eastern Malleable Iron Co., Naugatuck, Conn., is considering the erection of a foundry building, one story, 50 x 250 feet, at Watervliet, N. Y.

Erection of a new factory building at an estimated cost of $50,000 is being planned by the James Graham Mfg. Co., Newark, Cal., manufacturer of stoves, ranges, etc.

Plans for the erection of an addition to its plant recently were filed by the Wasserman Water Heater Mfg. Co., Burton street, Los Angeles. The addition will be 40 x 65 feet.

The Acme Pattern & Tool Co., Buffalo, N. Y., has leased a factory building on Courtright street, Bridgeburg, Ont., where it plans to establish a Canadian branch factory.

Capitalized at $10,000 the Gartland Danville Foundry Co., Danville, Ind., recently was incorporated by C. E. Swank, C. P. Osborn and O. V. Coon.

The Peoples Stove Co., Marion, N. C., recently was incorporated with a capital stock of $25,000 by C. F. James, A. C. Cranford and others.

The Acme Brass & Pattern Works, 609 East Seventh street, Kansas City, Mo., plans the erection of a 2-story plant building at an estimated cost of $15,000.

Capitalized at $16,000, the Crown Foundry Co., Hersheel street, Peoria, Ill., recently was incorporated by Frank Barr, O. B. Slater, H. E. Hire and J. D. Armstrong.

The Parker Street Castings Co., Cleveland, recently was incorporated with a capital stock of $65,000, by H. B. Frischmuth, Frank Witasek and others.

The Lansdale Foundry Co., Lansdale, Pa., manufacturer of gray iron castings, has made numerous improvements to its plant in the last few months and is again manufacturing a full line of steam and hot water heaters.

A part of the plant of the Enterprise Foundry Co., Manhattan and Nixon streets, Northside, Pittsburgh, manufacturer of iron and steel castings, recently was damaged by fire. The loss was estimated at $50,000.

The W. L. Lemly Foundry Co., Bessemer, Ala., manufacturer of cast iron pipe, is reported planning enlargements to its plant. The company recently acquired the plant of the Columbus Foundry Co., Columbus, Ga.

The Hesse-Ersted Iron Works, Portland, Oreg., recently was incorporated with a capital stock of $150,000 by Fred Hesse, A. J. Ersted and others, to engage in a general machine shop and foundry business.

William C. Hespe, Vienna, N. J., has acquired the foundry of Daniel D. Wolfe, manufacturer of plows, castings, etc., and is reported planning to remodel and improve the structure for the manufacture of stoves and ranges.

The American Foundry & Mfg. Co., 2027 Brooklyn avenue, Kansas City, Mo., will hold in abeyance the erection of its proposed new plant, which will be one story, 90 x 135 feet, plans for which are completed.

The Inter-State Safety Appliance Co., Beech and Noble streets, Norristown, Pa., which was recently organized, will engage in manufacturing and jobbing of all kinds. It will shortly be in the market for foundry equipment, woodworking and stamping machinery.

The Pacific Malleable Iron Co. has been incorporated with a capital stock of $50,000 at Gresham, Oreg. The company plans to erect a foundry building at an estimated cost of $10,000, on a site which it recently acquired. M. Moga is president of the company.

The Sterling Stove Co., Portsmouth, O., has been incorporated with a capital stock of $100,000 to manufacture gas cooking and heating stoves. The company has a plant at Tenth and Scott streets, Cincinnati. Incorporators are Henry Scott and B. W. Houkins.

The H. & D. Mfg. Co., Racine, Wis., has been incorporated with a capital stock of $25,000, and will establish a plant for the manufacture of pistons, piston rings and similar gas-engine and automobile parts, etc. The company was incorporated by Martin Horeth, William C. Draeger, Joseph F. Dodd, Walter R. Draeger and Charles Jenista, all of Racine.

The Tomah Iron Works, Tomah, Wis., which for some time has conducted a public garage, machine and automobile repair shop in connection with its foundry and general machine shop, has been incorporated as the Tomah Iron Works Garage, Inc., with a capital stock of $30,000. The incorporators of the company are Robert S. Murray, Carl A. Sweet and Harry M. Warren.

The Cabirange Mfg. Co. has increased its capital stock from $250,000 to $750,000, and will remove its plant from Taylorville, Ill., to Granite City, Ill., where a site has been acquired and buildings are now being erected at an estimated cost of $125,000. In addition to assembling ranges the company will make and prepare all parts in its new plant, which will include a foundry and an enameling department.

The Beeby Range Co., Ltd., Brockville, Ont., is establishing a plant for the manufacture of burners, ranges, etc. The company has rented 6600 square feet of floor space from Machinery & Foundries, Ltd., and expects to have its plant equipped and in operation within the next few weeks. Directors of the company include: A. Dion, A. J. Major, J. H. Beeby, C. A. Seguin, all of Ottawa, Ont., and J. E. Gravelle, Hull, Que.

Installation of additional machinery and equipment, and the erection of additional buildings which will increase production 100 per cent, is planned by the Interstate Aluminum Co., Canton, O., which recently increased its capital stock from $35,000 to $60,000. Arrangements are now being made to install new machinery in various departments but work on a new structure will not be commenced before spring, according to J. W. Fenstermaker, secretary of the company.

Harry W. Bolens, president and general manager of the Gilson Mfg. Co., Port Washington, Wis., has purchased at public auction the plant, equipment and other property of the Globe Metal Products Co., Sheboygan, Wis., for $65,700. It consists of a gray-iron foundry and machine shop. The Gilson company manufactures gas engines, implements, farm tools, etc., and in addition does a large jobbing business. Mr. Bolens expects to make a statement regarding the use to which the Globe plant will be put.

Completion of a new foundry for the Southbridge Foundry Co., Southbridge, Mass., recently was announced. The building was erected by the Truscon Steel Co., Youngstown, O. The main building is of steel and reinforced concrete construction, one story, 50 x 100 feet, with an ell, 20 x 30 feet. Frank S. Mills, formerly of Palmer, Mass., is president and general manager of the company, and Arthur A. Allard is treasurer. The company manufactures iron castings of all kinds, and is the only foundry in Southbridge, a town of 15,000 population.